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ART. I.—*Account of some Volcanic Springs in the Desert of the Colorado, in Southern California;* by JOHN L. LECONTE, M.D.

IN October, 1850, being at Vallecitas, San Diego Co., California, it was my good fortune to make a visit, in company with Major Heintzelman and Mr. Matsell, to certain boiling springs, not similar to any which have been noticed in our territory; and as the only account yet given of them has appeared in a newspaper, it seemed to me, that the rough notes taken while making the visit, might with slight changes be of interest to my scientific friends.

Mysterious accounts had been given us of a 'Volcan' situated in the midst of a plain covered with salt, near the shore of a lake: and although most of the salt used by the inhabitants of the mountains east of Santa Isabel was brought from this lake, no very definite account either of the distance of the lake, or of the phenomena to be seen there, could be procured. It was only apparent that some awe-inspiring object had heretofore defended itself against the prying curiosity of man.

Major Heintzelman, then in command of the troops about to be stationed at the Gila river, having determined to visit these objects of unknown interest, kindly offered me an opportunity of joining his party.

Having secured as guides the interpreter from Santa Isabel, and the head chief of the 'Lleguina' Indians living near the Salt Lake, we left San Felipe a short time after the rising of the moon on the morning of the 28th of October.

Entering almost immediately a small cañon, by which we ascended a rocky ridge, we soon descended again into a narrow deep cañon trending N.E.; this we followed for several miles, encountering in our route many precipitous places, over which we had great difficulty in leading our horses. The rocks were metamorphic, of a gneissoid and sienitic character, and the scanty vegetation was similar to that of Vallecitas; the most conspicuons objects being Larrea mexicana, Fouquiera spinosa, Prosopis, Agave and a variety of brittle and uncouth looking Opuntiæ, both of the flattened and cylindrical forms.

The cañon finally entered a long valley, in which were remains of some Indian huts, now abandoned from the failure of water.

The valley opened abruptly by a gap through the most eastern mountain range, and at 8 A. M. we found ourselves on the edge of the great desert, though still considerably above the general level of its surface. An extensive but peculiarly uninteresting prospect was before us; an immense plain extended to the eastern horizon, broken towards the north by some slight inequalities; masses of rock lay around us on the mountain side; the mountain itself, appeared a wall of naked rocks, and it was only within a small circle of vision, that an earth colored vegetation could be observed; as if the influence of our own living selves had communicated a fictitious vitality to the spot where we stood, which soon would depart with us, and leave the ghosts of plants to shrink again into the rocks from which they had been evoked by our presence.

At an indefinite distance towards the N. E. was seen a low range of mountains, near which a silvery surface with a slight fog resting over it seemed to indicate water. This the guides declared was the Salt Lake, on the shores of which were the objects of our search, and confidently assured us that we should reach it before night.

Halting here for breakfast, some excellent capon, and hard bread, washed down with a limited draught from our canteens soon prepared us for the dreary ride; the only resources to shorten the way being very limited geology, and as may be inferred from the nature of the country, equally poor botany. It is no wonder that Government reports abound with names of plants, which suggest nothing but linguistic difficulties, for there is little else in the vast deserts of Western America to occupy the attention of the intelligent traveller; and with the determination of one resolved to struggle with the dull sublimity of inorganic matter, he frequently breaks off and preserves a piece of some hideous vegetable, whose only charms are the ugliness of its form, the lifelessness of its color, and the apparent absence of flower, and foliage, and every thing else that renders a plant attractive.

Overlying the metamorphic rock was seen a conglomerate of great thickness, similar to that which at Vallecitas forms the

greater portion of the eastern range of the Sierra: boulders frequently of immense size, but scarcely rounded, torn in former ages from the adjacent ranges of mountains, are cemented together by a small quantity of calcareous matter enveloping gravel of different degrees of fineness: this cement presents somewhat the appearance of bad mortar. Outside of this conglomerate was seen unstratified drift. Beyond the mountains, can be traced on the desert a tertiary formation similar to that of San Diego, and above this stratified drift. These formations are nearly horizontal and form low ridges. The vegetation was still similar to that of Vallecitas, with the addition of a very large Echinocactus, of which several grew occasionally from one base: Opuntia vaginata was also seen, and an Ephedra appeared with a species of Koeberlinia. These gradually faded out, till at last nothing remained but Prosopis, Larrea, and a plant at that season leafless. The desert contains three principle levels; of these the upper (consisting of the part near mountain ridges) is covered with gravel, small stones from the mountains, silicified wood and oyster shells; the middle level is sandy, and the lower one clayey, with great numbers of fresh water shells scattered over its surface: among these the only bivalve is a species of Anodon, now found in the Colorado River, (A. californiensis *Lea*); the other species are small univalves, belonging to Physa, and Amnicola. These clayey parts extend for many miles, and are evidently the beds of lagoons, which on rare occasions may be filled with water; they belong to the New River system of overflow, hereafter to be described. Having travelled from the mountains a nearly east course, we encamped about 4 P. M. on the bank of a small stream running northwardly to the Salt Lake: the banks were precipitous, about twenty feet in height, and the waters disagreeably saline. This stream is evidently Cariso creek, which being lost in the sands a few miles from its source here reappears on the lower level of the desert: some rushes growing on the edge of the water furnished food for our horses.

Starting the next morning at 3 A. M. we arrived about 10, at an Indian village situated on New River, which is here near its termination, and probably when the supply is abundant, sends a portion of its water to the Salt Lake: at present there are only two or three small pools near the village.

New River is an important object to those compelled to cross the desert, since from it is derived the chief supply of water, to be found between Cariso creek and the Colorado. It is in reality a slough of the latter, which is only different from the ordinary sloughs near the river by its greater length, extending by a very tortuous course 70 or 80 miles from the point where it leaves the river. The bed of the Colorado, like that of other rivers carrying a large amount of sediment, is above the lower portions of the adjacent country, which are thus, in time of overflow supplied

by these sloughs; frequently however the annual rise of the river is not sufficient to supply New River with water, and should this occur for two years in succession the lagoons along its course become entirely dry, and the difficulty of crossing the desert is much increased.

The whole course of New River is marked by a large species of Chenopodium, called 'Kelite' by the natives, and 'careless weed' by the emigrants; it furnishes almost the only food for cattle and horses to be found in this region: the seeds are used by the Indians in preparing a kind of cake, which is quite palatable, when nothing else can be procured. The green leaves (if they ever are green) may be used as a salad, or boiled as a vegetable.

The ground passed over before arriving at the village was in many places covered with a thin layer of sandstone, forming occasionally concretions like claystones; this sandstone has apparently been formed by springs similar to those seen afterwards. The dust was sometimes extremely fine and incoherent, so that the feet of the horses would sink from six to eight inches; many pieces of pumice were also found stranded on the surface.

The Indian village contained about fifty inhabitants, who received us in a very friendly manner, offering us melons, beans and pumpkins, which they raise in abundance. Visiting the village were some Yumas from the Colorado, who recounted to Major Heintzelman the depredations committed by the grand army of California, recently sent under one Major General Morehead, to avenge the murder of a party of ferrymen at the junction of the Colorado and Gila. Though these depredations were not remarkable, the Indians had apparently had enough of the war, and learning that a military post was soon to be established, they became very anxious to make peace, until another opportunity for safely committing some outrage should occur.

After resting our horses, we started with an escort of seven or eight Indians, who used all the power of their eloquence to dissuade us from going. Nevertheless, on our exclaiming that we had come a long distance to see these volcanoes, and that we would seek them for ourselves, if they were afraid to accompany us, the debate ceased, and we rode on in a northwesterly direction. After going about eight miles, we reached a soft muddy plain bordering the Salt Lake: the salt in consequence of a recent shower had almost disappeared, only a few crusts about half an inch thick now remaining. The deposit is said to be sometimes a foot in thickness.

North of the lake, and now distant from us six or eight miles, is a chain of rocky hills 800–1000 feet high, portions of which have a volcanic appearance. Rising from the plain, where we now stand, are several volcanic mounds about 100–150 feet high; hastening to one of these, I found it composed of lava,

and pumice: several of these mounds are arranged in an arc of a circle, but the general direction is a little west of south.

Having arrived thus far, and given our horses in charge to some of the Indians, the interpreter again endeavored to dissuade us from further exploration. He said that on approaching the springs, the steam from which was now distinctly seen, devils in the shape of large black birds rose from the ground, and descended with overwhelming force on the head of the rash adventurer: he stated that a tradition still existed among the Indians, of one Juan Lonquiss (Longecuisse? perhaps a "Crapaud" trader) who had met this dreadful fate, and asked us in a pathetic tone, how he could return to his town, if we too were sacrificed in this way. We replied, in substance, that devils had no power over us, and that we were stronger than they, and that probably they were aware of that fact, and would not appear during our visit.

This seemed very blasphemous to their ears, and the whole escort suddenly dropped behind, leaving us to our fate.

Advancing towards the place, whence the steam issued, we found in the muddy plain numerous circular holes containing boiling mud, and exhaling a naphtha-like odor. Many of them are encrusted with inspissated mud, forming cones 3–4 feet high, from the apex of which proceed mingled vapors of water, sal-ammoniac and sulphur. Four of them eject steam and clear saline water, with great violence, resembling in appearance the jet from the pipe of a high-pressure engine. The falling spray around these has formed a group of acicular stalagmites, composed of aragonite with a small quantity of silica and some saline matter: many of these stalagmites are tubular in form. Another spring was a large basin filled intermittingly to overflowing with foam and clear saline water: around the edge were botryoidal masses of aragonite, like that forming needles around the cones. Near the cones, in little fissures, were crusts of sal-ammoniac,* some of which were colored red, possibly by sulphuret of selenium.

The Indians, finding that the black devils did not assail us, ran up to us, with great exultation, and leaped about, and danced in such an extravagant manner, that we were obliged to caution them of the danger of breaking through; the solid crust was evidently very thin, as it bent and trembled under our weight in a very threatening manner.

In returning we found on the most northern of the volcanic mounds before mentioned a quantity of scoria and obsidian, and distinctly traced the course of a lava stream down the side. The mounds all showed traces of aqueous action, in the terrace-like manner in which the pumice was arranged. The rest of our

* The specimens of saline crusts having been subsequently lost, I cannot be certain that they were really sal-ammoniac, and only refer them to that salt from the sharpness of their taste.

course to the Indian village was unmarked by any incident worthy of note. The next day about 12, having taken a supply of musk-melons as our only food, we started for Vallecitas. The afternoon was windy, and, a rare phenomenon in this region, showery. About nine or ten miles from the village, we passed some mounds covered with cinders and pumice, and on the top of one of them found a crater-like hollow, in which grow some very large canes. Shortly afterwards the strata of fresh water deposit were seen to be vertical, and were filled with a species of Gnathodon (G. Lecontei *Conrad*). About 4 P. M., we skirted along the northern edge of a long curved range of hills, the base of which was composed of strata of limestone dipping outwardly, and containing also Gnathodon; around these hills and mounds were concentric lines of small stones from the mountains arranged by aqueous action.

About half past five, we encamped in the bed of Cariso creek, here entirely dry; the night was stormy, but a melon apiece, and the warmth of a large mesquite fire soon made us contented. Leaving at four the next morning, we reached Vallecitas in the afternoon, without farther adventure, worthy of being here narrated.

NOTE.—By the kindness of Capt. Davidson, I learn that while he was stationed at Fort Yuma, in Dec., 1853, a violent earthquake occurred; the ground in the vicinity of the Fort opened, forming fissures, from which were thrown mud, sand and water: portions of the mountains several miles distant were seen to fall, and about forty miles S. E. of the Fort, in the direction of some springs, said to be similar to those herein described, was seen an immense column of steam. It is to be hoped that some of the officers then at the post will favor science with an account of the phenomena observed.

ART. II.—*On the Geographical Distribution of Crustacea;* by JAMES D. DANA.

(Continued from vol. xviii, p. 326.)

V. TETRADECAPODA.

BEFORE stating the conclusions from the tables* of the Tetradecapoda, it should be observed that this division of Crustacea has been less thoroughly explored than that of the Podophthalmia, and future investigations must vary much the proportions between the species of the different regions. The coasts of Europe and the northern seas, are within the reach of European zo-

* As already mentioned the Tables published in the original Report are here omitted.

ologists, and have been carefully examined; while voyagers through the tropics have usually contented themselves with collecting the larger Crustacea. In the genus Gammarus, not a tropical species had been reported, until our investigations, which brought ten or eleven to light, being one-third the whole number of those of ascertained localities reported to this genus.

Some general conclusions may, however, be safely drawn from the facts already known, although the exact ratios deduced from the tables may hereafter be much modified.

I. The Tetradecapoda are far more numerous in extra-tropical latitudes than in the tropical.

The proportion in the table is 521 : 146; allowing for future discoveries, it may be set down at 2 : 1, without fear of exceeding the truth.

II. The *genera* of extra-tropical seas are far more numerous than those of the tropical.

Out of the forty-nine genera of *Isopoda*, only nineteen are known to occur in the tropics, and but four of these are peculiar to the tropics.

Out of twenty genera of *Anisopoda*, six only are known to be tropical, and but two are exclusively so.

Among the *Amphipoda*, out of fifty genera of *Gammaridea*, only seventeen are known to contain tropical species; nine are exclusively tropical, and but ten, including these nine, have more tropical than extra-tropical species. The Caprellidea and Hyperidea embrace thirty genera, fifteen or sixteen of which include tropical species.

The variety of extra-tropical forms compared with the tropical, is hence very great.

III. From the tables, the ratio of extra-tropical and tropical species in the

Isopoda, is	4 : 1
Anisopoda, ...	6 : 1
Amphipoda, ...	3 : 1

Among the Isopoda, the Idotæidea are the most decidedly cold-water species, and the Cymothoidea, the least so. The ratio of species for the

Idotæidea, is	8 : 1
Oniscoidea, ...	7 : 1
Cymothoidea, ...	2½ : 1

Two-ninths of the extra-tropical Idotæidea (or nine species) belong to the Frigid zone, and nearly one-tenth of the extra-tropical Oniscoidea (or nine species); while less than a twenty-fifth of the Cymothoidea occur in the Frigid zone, and but one of these has not also been found in lower latitudes.

Of the Amphipoda, the Gammaridea are most strongly extra-tropical, the proportion being for the extra-tropical and tropical

species $3\frac{1}{2}:1$; while the ratio in the Caprellidea, is 3:1; and in the Hyperidea, $1\frac{1}{4}:1$. Out of one hundred and seventy-eight extra-tropical species of Gammaridea, sixty-six are Frigid zone species, besides two which have been found both in the Frigid and Temperate zones.

IV. The genera which extend into the frigid region are the following. The names of those more especially frigid, according to present knowledge, are italicised; and the proportion of frigid species to the whole number of extra-tropical, is mentioned in decimals, where they are not exclusively frigid.

Idotæidea.—Idotæa (0·3), *Glyptonotus.*
Oniscoidea.—Jæra (0·25), *Jæridina*, Asellus (0·20), Janira (0·5), *Henopomus*, *Munna* (0·66).
Cymothoidea.—*Æga* (0·4).

Serolidea.—Serolis (0·2), Praniza (0·15), Anceus (0·25).
Arcturidea—Arcturus (0·5).
Tanaidea.—Tanais (0·5), *Liriope*, *Crossurus*, *Phryxus*, *Dajus.*

Caprellidea.—Proto (0·5), Caprella (0·24), *Ægina*, *Cercops*, *Podalirius.*
Gammaridea.—*Dulichia*, *Siphonœcetes*, Unciola (0·5), Podocerus, (0·5), *Laphystius*, Orchestia (0·07), *Stegocephalus*, Opis (0·66), *Uristes*, *Anonyx*, (0·9), Leucothoe (0·66), *Acanthonotus*, (0·75), *Iphimedia* (0·6), Œdicerus (0·5), Gammarus (0·33), Melita (0·5), *Pardalisca*, *Ischyrocerus*, *Michrocheles*, *Pontoporeia*, *Ampelisca*, *Protomedeia*, *Phoxus.*

Hyperidea.—Hyperia (0·14), *Metœcus*, *Tauria*, *Themisto*, (3·0).

The Spheromidæ are nearly all cold-water species, though not reaching into the Frigid zone. There are forty-nine known species of Spheromidæ in the Temperate zone, and but *four* in the Torrid. *Serolis* is a peculiar cold-water form, belonging mainly to the subfrigid and frigid regions. *Orchestia* is to a large extent of the Temperate zone, while *Allorchestes* is more equally distributed through the torrid and temperate. Amphithoe, as restricted by us, is alike common in the torrid and temperate regions; while Iphimedia, the other section of the old group, is mainly a cold-water genus.

The Hyperidea are mostly tropical genera.

V. The species and genera of Tetradecapoda are not only most abundant in the extra-tropical regions, but besides, the individuals of species appear to be more numerous, or at least not less so. At Fuegia, the quantity of Gammaridæ collected on bait dropped in the water was exceedingly large; and in no region visited by us, did we find evidence of as great profusion. The Spheromæ were also very abundant along the shores.

VI. Moreover, the species of extra-tropical waters are the largest of the tribe. In the Frigid zone, there are Idotæidæ three to four inches long, while the average size of the tropical species is less than three-fourths of an inch; there are Spheromæ an inch long, while those of the tropics seldom exceed a fourth of an inch; there is a Lysianassa three inches long, while

the warmer seas afford only small species half an inch in length; there is a Pterelas over an inch in length, while the Ægidæ of the tropics are less than half an inch. The Gammari of the tropics are small slender species, not half the size of those of the colder seas. The species of Serolis are an inch to two inches long. Thus, through the Idotæidæ, the Ægidæ, Serolidæ, Spheromidæ, Caprellidea, and Gammaridea, the largest species belong to the colder seas, and the giants among Tetradecapods, are actually found in the Frigid zone.

Among the Hyperidea there is one gigantic species, belonging to the genus Cystisoma, which is over three inches long. It is reported from the Indian Ocean, but whether tropical or not, is unascertained. Of the species of this group examined by the writer, the largest, a Tauria, was from the Frigid zone.

VII. Again, the Tetradecapoda of extra-tropical waters are the highest in rank. Among the Isopoda (which stand first), the Idotæidea appear to be of superior grade, and these, as observed, are especially developed in the colder seas, reaching their maximum size in the Frigid zone. Again, the Serolidæ, the highest of the Anisopoda, are cold-water species. The Orchestiæ among the Amphipoda, although reaching through both the Torrid and Temperate zones, are largest and much the most numerous in the latter.

VIII. Those species of a genus that occur in the colder waters, are often more firmly put together, and bear marks of superiority in their habits. The Amphithoe and Gammari of the tropics are lax and slender species, of small size compared with those of the colder seas.

IX. There is a tendency in the colder waters to the development of spinous species. This fact is as true of the Podophthalmia as of the Tetradecapoda. Among the former, there are the thorny *Lithodes*, the numerous *Maioids* armed with spines, the *Acanthodes;* while the Cancroids and Grapsoids of the tropics are usually very smooth and often polished species. There are the spinous boreal Crangons, the species of which genus in the warmer seas are without spines. Among the Tetradecapods, the *boreal* Iphimediæ are often spinous or crested; Acanthonotus and Dulichia are spinous genera. The same tendency is seen in the third pair of caudal stylets in some cold-water Gammari, which have the branches spinulous instead of furnished with a few minute hairs like those of the tropics.

There are also some spinous Crustacea in the tropics, as the Palinuridæ and species of Stenopus. Such facts, however, do not lead to any modification of the previous remark; for the tendency observed is still a fact as regards the several genera mentioned; moreover the spinous tropical species are few in number.

VI. ENTOMOSTRACA.

The Entomostraca have been little studied out of the Temperate zone, if we except the results of the author's labors. The described species of most of the families are, therefore, almost exclusively from the temperate regions, and we know little of the corresponding species or groups in the warmer seas. The following table presents the number of known species of the torrid and extra-torrid zones, omitting the Lernæoids:—

TABLE IV.

	Torrid zone.	Extra-torrid zone.
LOPHYROPODA.		
Cyclopoidea,	120	76
Daphnioidea,	5	46
Cyproidea,	13	61
PHYLLOPODA.		
Artemioidea,	0	10
Apodoidea,	0	3
Limnadioidea,	2	2
POECILOPODA.		
Ergasiloidea,	1	4
Caligoidea,	16	33

Were we to leave out of view the researches of the author, the number of species and the proportion for the Cyclopoidea, instead of 120 to 76, would be about 3:50, thus not only reversing the ratio, but giving to the Temperate zone almost all the species of the group.* Moreover, no Daphnioids and few Caligoids have been yet reported from the Torrid zone, excepting those described in this Report. The author's time when on land in the tropics was devoted mainly to the department of Geology, and consequently the fresh-water Entomostracans were not as thoroughly collected as those of the oceans. He therefore attempts to draw no conclusions from the above ratios.

A few facts may, however, be deduced with respect to some genera, and especially those of the Cyclopoidea. The following table gives the number, as nearly as known, of the species of each genus of the Cyclopoidea, occurring in the torrid and extra-torrid zones. The number common to the extra-torrid and torrid zones is mentioned in brackets.

* The whole number of Cyclopoidea described previous to May, 1842, by which time the author's observations were completed, was less than *twenty-five*; and of the oceanic Cyclopoids, one hundred and fifty species of which the author has described, not *ten* were then known. We may judge from these results of a single cruise what still remains to be done in the department of Entomostraca.

TABLE V.

CYCLOPOIDEA.

	Torrid.	Extra-torrid.
I. Calanidæ.		
1. *Calaninæ.*		
Calanus, . .	25	12 (3)
Rhincalanus, .	2	
Cetochilus, .		1
Euchæta. . .	4	1
Undina. . .	3	
2. *Oithoninæ.*		
Oithona, . .	2	1
3. *Pontellinæ.*		
Diaptomus, .		2
Hemicalanus, .	4	
Candace, . .	5	1
Acartia, . .	3	1
Pontella, . .	22	9 (3)
Catopia, . .	1	
4. *Notodelphinæ,*		
Notodelphys, .		1
II. Cyclopidæ.		
1. *Cyclopinæ.*		
Cyclops, . .	2	9
? Psammathe, .		1
? Idomene, .		1
? Euryta, . .		1

	Torrid.	Extra-torrid.
2. *Harpacticinæ,* .		
Canthocamptus,	2	4
Harpacticus, .		15
Westwoodia, .		1
Alteutha, . .		1
Metis, . . .		1
Clytemnestra, .	1	
Setella, . . .	5	1 (1)
Laophon, . .		1
Oncæa, . . .		1
Ænippe, . .		1
Idya, . . .		1
3. *Steropinæ.*		
Zaus, . . .		1
Sterope, . . .		4
III. Corycæidæ.		
1. *Corycæinæ,*		
Corycæus, .	18	1
Antaria, . .	3	1 (1)
Copilia, . .	2	
Sapphirina, .	15	5
2. *Miracinæ.*		
Miracia, . .		1
Total Calanidæ, . .	71	29 (6)
Total Cyclopidæ, .	10	44 (1)
Total Corycæidæ, .	39	8 (1)

The properly oceanic genera include all the *Calanidæ*, excepting *Diaptomus* and *Notodelphys;* all the *Corycæidæ;* with only the single genus *Setella* among the Cyclopidæ.

Among the Calanidæ, the genera are mainly tropical, yet each affords some extra-tropical species; and those which are most abundant in the colder waters are Calani or closely allied. *Setella* occurs beyond the tropics; but all the species thus far examined are found in the Torrid zone. *Pontella* is more of a warm-water genus than Calanus. The Corycæidæ are to a large extent tropical; the genus *Corycæus* is almost exclusively so, while *Sapphirina* is common in the Temperate zone. The Steropinæ are Frigid species.

Although the Calanidæ are more varied in species within the tropics, they abound more in individuals in the colder seas. Vast areas of "bloody" waters were observed by us off the coast of Chili, south of Valparaiso (latitude 42° south, longitude 78° 45′ west, and latitude 36° south, longitude 74° west), which were mainly due to a species of this group; and another species was equally abundant in the North Pacific, 32° north, 173 west.* They have been reported as swarming in other seas, constituting

* The species in the former case was the *Pontella* (subgen. *Calanopia*) *brachiata;* and in the latter, *Calanus sanguineus.*

the food in part of certain species of whale. Such immense shoals we did not meet with, within the tropics.

Among the *Daphnioidea*, the genera Daphnella, Penilia, Ceriodaphnia, and Lynceus were observed by us in the Torrid zone. Of the *Cyproids*, Cypridinia, Conchœcia, and Halocypris are oceanic forms, and mainly of the tropical oceans.

The *Caligoids* spread over both zones. Caligus and Lepeophtheirus reach from the equator to the frigid seas; Nogagus, Pandarus, and Dinematura are represented in both the Torrid and Temperate zones.

GENERAL REMARKS AND RECAPITULATION.

We continue by presenting a few general deductions from the tables, and a recapitulation of some principles.

A survey of all the great divisions of Crustacea, shows us that exclusive of the Entomostraca, they are distributed, according to present knowledge, as follows:

	a. Torrid zone.	*b.* Temperate zone.	*c.* Frigid zone.
Brachyura, . .	535	257 (34 *a*)	2 (5 *b*)
Anomoura, . .	125	110 (15 *a*)	4 (1 *b*)
Macroura, . .	148	125 (16 *a*)	29 (2 *b*)
Anomobranchiata, .	82	33 (9 *a*)	2
Isopoda, . . .	56	208 (1 *a*)	21 (3 *b*)
Anisopoda, . .	8	34	15
Amphipoda, . .	82	157	83 (4 *b*)
Total, . .	1036	924 (75 *a*)	159 (14 *b*)

Taking the sum of the Frigid and Temperate zone species (subtracting the fourteen common to the two) we have 1036 species in the torrid regions to 1069 in the extra-torrid, seventy-five of which are common to the two. This shows a nearly equal distribution between the zones. But excluding the Brachyura, the numbers become 501 to 811, giving a preponderance of more than one-half to the Temperate zone.*

* Adding to the numbers above, the species which have been necessarily left out as of uncertain locality, amounting to one hundred and forty in all, and inserting also the Entomostraca, it makes the total of described living species in 1853, as follows:—

Brachyura, ...	830	
Anomoura, ...	262	
Macroura, ...	297	
		1389
Anomobranchiata, (Mysidea, Squilloidea, Amphionidea,) .		115
Isopoda, ...	295	
Anisopoda, ...	57	
Amphipoda, ...	341	
		693
Entomostraca, ...		492
Total, ...		2689

The number of species collected in the cruise of the Expedition (exclusive of those lost in the wreck of the Peacock, which included nearly all the collections of

The species of highest rank among the Brachyura, Macroura, Isopoda, and Amphipoda, the four principal types in the above, belong to the extra-torrid zones; and in subordinate groups or families, it is often true that the genera of superior grade are extra-torrid, in contrast with the others which are torrid genera. Higher groups, characteristic of the colder regions, sometimes show degradation among those species of the group that are tropical; and the tropical sections also may continue the line of degradation by an extension again into the colder seas.

As we descend in the scale of Crustacea from the Podophthalmia to the Tetradecapoda, the number of cold-water species increases, becoming in the latter group, three times greater than the warm-water species. It is an important fact, nevertheless, that this increase of cold-water species is still no mark of degradation; the particular facts that have been discussed, leading to a very different conclusion. Other principles follow. These are—

First, that the two types, the Decapodan and Tetradecapodan, are distinct types, to be independently considered, and not parts of a series or chain of species—a fact illustrated in the chapter on the Classification of Crustacea.

Second, that the preponderance of cold-water species is the reverse of what must have been true in the earlier geological epochs, when the oceans had a somewhat higher temperature; or were to a large extent tropical.

Third, that the progress of creation as regards Crustacea, has ended not where it begun, in multiplying the species of warmer waters and giving them there their superior developments, but in carrying species to a higher perfection in the colder regions of the oceans. A preponderance of species in the warmer seas is perhaps to be expected, since warm waters have prevailed even more largely than now in earlier epochs. But it would seem, that the introduction of the higher grades of Crustacea required, not merely the cooler waters of the present tropics, but even the still colder temperature of the Temperate zone, and therefore the present condition of the globe.

two seasons in the tropical regions of the Pacific) is nearly 900; and the number of new species described is 658, distributed among the groups as follows:

Brachyura,	151	
Anomoura,	50	
Macroura,	57	
Anomobranchiata,	28	
		286
Isopoda,	67	
Anisopoda,	7	
Amphipoda,	110	
		184
Entomostraca,	188	
Total,	658	

The genera of Fossil species commence with the Entomostracans and Trilobites in the Palæozoic rocks. Next appear certain *Thalassinidea* and *Astacoid* species, in the Permian system; then *Mysidea*, *Penæidea*, many *Thalassinidea*, *Astacoidea*, and *Anomoura*, in the Oolitic system; then a few *Cancroids* and *Leucosoids* in the Cretaceous, which become much more numerous in the *Tertiary* system, along with some *Grapsoids*. None of the *Maioids*, the highest of Crustacea, have yet been reported from either of the Geological epochs.

The *number* of individuals and the *size* are, for the Brachyura, greater in the Torrid zone than in the colder regions. But for the Macroura, the species of cold-water genera average nearly twice the lineal dimensions of those of warm waters; and the number of individuals also may possibly be greater.

In stating the conclusion respecting the Macroura, on a preceding page (last volume, p. 325), we omitted to give in detail the mean sizes of the different groups. The following are the results, including the Galatheidea which are closely related to the Macroura:—

	Mean length of Torrid zone species.	Mean length of Extra-torrid species.
Galatheidea,	0·3 inches.	3·0 inches.
Thalassinidea,	2·0 "	3·0 "
Scyllaridæ,	6·0 "	6·0 "
Palinuridæ,	12·0 "	15·0 "
Astacidæ.—Homarus,		14·0 "
Astacinæ,		3·0 "
Nephrophinæ,		5·0 "
Crangonidæ,		2·0 "
Palæmonidæ.—Alpheinæ,	1·5 "	1·5 "
Pandalinæ,		3·0 "
Palæmoninæ,	2·3 "	2·4 "
Oplophorinæ,	1·0 "	
Penæidæ,	3·6 "	4·5 "

The table shows that the torrid species, in none of the groups, average larger than the extra-torrid. The cold-water Palinuridæ are as large as the largest warm-water species, and will outweigh them; the cold-water Galatheidea, are ten times the average length of the warm-water; the Alpheinæ, Palæmoninæ, and Penæidæ are at least as large in the temperate regions as in the torrrd. There is hence nothing in the tropics to balance the Astacidæ, a group of large species, some of them gigantic; nor the Crangonidæ, nor Pandalinæ. The genus Palæmon, in the Torrid zone, averages larger than in the Temperate, the ratio being 3·5 to 2·4; the former amount being reduced to 2·3 for the Palæmoninæ, by the species of the other tropical genera, which are mostly quite small. Yet, taking the ratio of 3·5 to 2·4, it affects but little the balance against the Torrid zone.

As to *bulk*, also, the Temperate zone probably has the preponderance; yet our data are less definite. In the Galatheidea, the cold-water species are not only ten times larger lineally (which implies at least eight hundred times cubically), but they are far more prolific, swarming in vast numbers where they occur. The Thalassinidea are more numerous in extra-torrid species than torrid, as well as larger in size. The Scyllaridæ are mainly tropical; but the species are not of common occurrence, compared with the Astacidæ, which abound everywhere, and these, as well as the Crangonidæ and Pandalinæ, are all Temperate zone species. The Palæmoninæ and Penæidæ probably preponderate in the tropics, and this may be also true of the Alpheinæ. Taking a general view of the whole, and considering the fact, that the extra-torrid species rather outnumber the torrid, we believe that the deduction above stated is correct.

In the *Tetradecapoda*, the number of species, the number and diversity of genera, the number of individuals, and the bulk, are all greater in the extra-torrid seas than in the torrid, as has been explained on a preceding page; and this is especially true of the Amphipoda.

The tendency to spinose forms among the species of the colder temperate regions, or Frigid zone, has been remarked upon on page 9, as exemplified among the Gammaridea, the Crangonidæ, Lithodes, and Maioids.

(*To be continued.*)

ART. III.—*Contributions to Mineralogy;* by Dr. F. A. GENTH of Philadelphia.

(Continued from vol. xviii, p. 410.)

5. *Tetradymite.*

AFTER making the examination of the Tetradymite from Davidson county, N. C. (Am. Journ., 2d Ser., vol. xvii, page 81), I was very desirous to reëxamine the mineral, which had been analyzed by Mr. Coleman Fisher, Jr., (Am. Jour., 2d Ser., vol. vii, p. 282). Fortunately Prof. R. S. McCulloh (who was at the time of its discovery at Commodore Stockton's mines in Virginia, Melter and Refiner at the U. S. Mint) had preserved some of the same material, which was analyzed by Mr. Fisher, and he very kindly gave me *all* that he had for examination. This was sufficient for the whole investigation. The pieces were of two different kinds, viz: Tetradymite associated with quartz and gold, and Tetradymite in broad folia, sometimes one inch in diameter, implanted in a decomposed micaceous slate. The latter mineral undoubtedly came from the Tellurium Mine, Fluvanna county, Va. and is that analyzed by Mr. Fisher; the former is

probably from the same place, but may be from Whitehall Mine, Spotsylvania county, Va.

Though I was most careful in selecting the material for this investigation, I found invariably from one half to two per cent. of quartz, gold and oxyd of iron mixed with it, which were deducted as impurites.

In making the investigation I have found the method heretofore used for the separation of bismuth from tellurium, by sulphid of ammonium, not to be as correct as is desirable, since there is always a considerable amount of tellurium remaining with the bismuth; I therefore tried to find another mode, which would give more satisfactory results, and succeeded best with the following: The solution containing teroxyd of bismuth and tellurous acid was made acid by hydrochloric acid, and to the hot solution bisulphite of ammonia was added. It was allowed to stand in a warm place for a day or two until all the tellurium had settled; this was filtered on a weighed filter, washed first with a mixture of diluted hydrochloric and sulphurous acids, then with sulphurous acid alone, and finally with water. The tellurium was completely precipitated and did not contain a weighable quantity of bismuth. The results of the analyses I. and II. were afterwards corrected, and III. and IV. analyzed by this method. B.B. it fuses readily giving out a faint but distinct odor of selenium, leaving on charcoal white incrustations with a yellow centre. The following results were obtained:

	I.	II.	III.	IV.	Calculated.
	From Tellurium Mine.			? From Whitehall Mine.	
Bismuth,	53·07	53·78	51·56	Not determ.	1 equiv. Bi=51·94
Tellurium,	48·19	47·07	49·79	46·10	3 " Te=48·06
Selenium,		*traces*			
Sulphur,	none	none	none	0·37	

These analyses show that neither of the specimens contained a weighable amount of selenium. The small quantity of sulphur (in No. IV,) 0·37 per ct. is equivalent to 1·48 per ct. of tellurium, which if we substitute tellurium for sulphur, would give 47·53 per ct. of tellurium. These analyses show that Tetradymite is tertellurid of bismuth, but that sometimes (as I showed for that from Davidson county) a variable quantity of tellurium may be replaced by sulphur. I have also observed that Tetradymite occurs at several localities in Cabarrus county, N. C., where I have found it in minute lead-colored scales, associated with gold and iron pyrites in quartz at the Phœnix Mine and at the Boger Mine; but, though I had sufficient material to determine the nature of the scales, I could not obtain enough for a quantitative analysis.

6. *Bismuthine.*

On examining some ores from Gold Hill, Rowan county, N. C., I found that the crevices in specimens from the Barnhardt vein

(from 280 feet below the surface) sometimes contained a steel colored mineral in minute acicular needles, which are apparently rhombic. It was associated with gold, iron and copper pyrites. B.B. it gave the reactions of sulphur, bismuth and copper, and once I observed a faint odor of selenium. Afterwards I found that the chloritic slate of the same vein, in which the copper pyrites occurs, contains also a considerable quantity of almost microscopic specks and stripes of the same color. On extracting some of the slate by aqua regia, the solution contained, besides iron and copper (probably from the copper pyrites), a considerable quantity of bismuth. Neither tellurium nor lead could be found. It is impossible to get a sufficient quantity of this mineral for analysis, or of sufficient purity to ascertain whether the copper, which I found, belongs to the mineral itself, or is owing to an admixture of copper pyrites—or, in other words, whether the mineral is "*Cupreous Bismuth*," or *Bismuthine*. I am in favor of the latter opinion.

7. *Aciculite.*

A mineral between lead and steel-gray in color occurs in small masses imbedded in quartz and associated with copper pyrites and sulphate of baryta. Though it is not found in long acicular needles, like the needle ore from Beresofsk in Siberia, a qualitative analysis showed that it contains the same constituents, viz: bismuth, lead, copper and sulphur.

B.B. it fuses readily, giving off sulphurous acid and covering the charcoal with yellow incrustations; with carbonate of soda, after the lead and bismuth have been volatilized, a globule of copper remains.

I therefore believe it to be "*Aciculite.*"

8. *Barnhardtite, a new mineral.*

a. In compact masses; no cleavage could be observed. H.= 3·5; Sp. grav. (at 25° Cels.) = 4·521; lustre metallic, but somewhat dull; color bronze-yellow; streak grayish black and slightly shining; opaque; fracture conchoidal, uneven; brittle; tarnishes very soon, more readily in presence of moisture, assuming a peculiar brownish, sometimes pinchbeck-brown, sometimes also rose-red and purple colors.

B.B. gives off sulphurous acid and fuses easily to an iron-black magnetic globule; with borax it gives the reactions of copper and iron; with carbonate of soda and borax metallic copper. It was analyzed in my laboratory by Mr. Wm. J. Taylor (I), Mr. Peter Keyser (III) and myself (II), and a copper determination was made by Mr. Chs. A. Kurlbaum (IV).*

* In analyses I. and II. a trace of brown hematite was mixed with the mineral; and in analysis II. some copper was lost.

The following are the results:

	I.	II.	III.	IV.	Calculated.
	From D. Barnhardt's land.	From Pioneer Mills.			
Copper,	47·61	46·69	48·40	47·86	4 equiv. Cu = 48·14
Iron,	22·23	22·41	21·08	not det.	2 " Fe = 21·33
Sulphur,	29·40	29·76	30·50	not det.	5 " S = 30·53
Silver,	*trace*				

The composition is expressed by the formula: $2Cu_2S+Fe_2S_3$, which is between that of yellow copper pyrites $=Cu_2S+Fe_2S_3$ and Erubescite $=3Cu_2S+Fe_2S_3$.

I have found this mineral associated with other copper ores at Dan. Barnhardt's land (hence its name) and Pioneer Mills, Cabarrus county; Dr. O. Dieffenbach observed it at the Phœnix and Vanderburg Mines of the same county, and I saw it also amongst copper ores from the neighborhood of Charlotte, Mecklenburg county, N. C. It seems to be abundant in North Carolina, and is of course a very valuable copper ore,

b. I will mention here another copper ore, which also occurs on Dan. Barnhardt's farm.

It is massive and resembles copper pyrites, but is somewhat paler. The material for analysis was uniform in appearance and seemed not to be a mixture of two species.

The analyses made by Messrs. Wm. J. Taylor (I) and Charles Froebel (II), gave the following results:

	I.	II.	Calculated.
Copper,	40·2	40·5	5 equiv. Copper = 39·67
Iron,	28·4	28·3	4 " Iron = 28·12
Sulphur,	32·9	31·1	8 " Sulphur = 32·21

The composition of this mineral may be expressed by the formula: $(2Cu_2S+Fe_2S_3)+(Cu\,S,+2Fe\,S.)$

Whether further investigations will prove this to be a distinct species or not, I am not able to say; for the present I only wish to call the attention of mineralogists to this subject.

9. *Gray Copper, (Fahlerz.)*

In the Am. Journ. of Sc., 2d Ser., vol. xvi, page 83, I have described the first mineral belonging to this group, which has been observed in this country. Since then I have found two new localities, where minerals occur belonging to this group, and a third one (Duchess county, N. Y.) was mentioned to me by Dr. Isaiah Deck.

a. From Eldridge's Gold Mine, Buckingham county, Va.—In granular masses; lustre metallic; color between iron-black and lead-gray; streak iron-black; opaque; H.=4. Very brittle; fracture uneven—subconchoidal.

B.B. in an open tube disengages sulphurous acid; and gives a sublimate of arsenious acid. On charcoal it emits fumes of an

alliaceous odor, and fuses with intumescence to an iron black, slightly magnetic globule, covering the charcoal with white incrustations. With fluxes it gives the reactions of copper and iron.

A preliminary analysis, made by dissolving the mineral in aqua regia, gave Mr. Wm. J. Taylor the following results:

Copper,	40·64 pr. cent.
Silver,	0·42
Gold,	*trace*
Zinc,	5·39
Iron,	4·24
Antimony,	5·10
Arsenic,	16·99
Sulphur,	28·46
Quartz,	1·24

It is associated with quartz and auriferous iron pyrites.

b. From Geo. Luderick's farm, about 14 miles N. E. of Concord, Cabarrus county, N. C.—The only imperfect crystal which I found appears to be a combination of $\frac{O}{2} \cdot \frac{2O2}{2} \cdot \infty O$; it is generally found massive; its color is between dark lead gray and iron black; streak iron black, somewhat brownish; fracture uneven, subconchoidal; brittle.

B.B. decrepitates slightly; in an open tube disengages sulphurous acid and gives a sublimate of arsenious acid; on charcoal it emits fumes of an alliaceous order, and covers it with white incrustations; it fuses into a magnetic globule and gives with fluxes the reactions of copper and iron. It is found in quartz, associated with copper pyrites, iron pyrites, brown hematite and scorodite.

10. *Geokronite.* (?)

I received this mineral amongst others from Tinder's Gold Mine, Louisa county, Va.

It occurs in small irregular masses of a crystalline structure, with distinct cleavage in one direction; lustre metallic; color lead gray; opaque; H. = 3; Sp. grav. (at 16° Cels.) 6·393.

B.B. upon charcoal gives off sulphurous acid and copious fumes of teroxyd of antimony, covering it with white incrustations, having a yellow centre of oxyd of lead; further reduced yields a small globule of silver; in an open tube it gives off sulphurous acid and a white sublimate of teroxyd of antimony and arsenious acid.

A rough experiment showed that it contains about 16 per cent. of sulphur, 60 per cent. of lead, and 0·25 per cent. of silver.

Associated with iron pyrites, galena and blende.

11. *Garnet.*

a. From Yonkers, N. Y.—This beautiful massive red garnet, which I have found in many collections labelled "Pyrope," has been examined in my laboratory, by Mr. Wm. J. Taylor.

B.B. it fuses to an iron black, slightly magnetic globule; with borax it gives the reactions of iron, and with carbonate of soda those of manganese. It is acted upon by hydrochloric acid, but not completely decomposed. The analysis gave the following results.

Silica,	38·32 per cent.	contains Oxygen	19·90		= 2
Alumina,	21·49	" "	10·05		= 1
Oxyd of iron (FeO)	30·23	" "	6·71		
Oxyd of manganese,	2·46	" "	0·55	10·16	= 1
Magnesia,	6·29	" "	2·51		
Lime,	1·38	" "	0·39		

b. From Greene's Creek, Delaware county, Pa.—Under the head "Pyrope," Prof. Dana mentions this beautiful gem, stating his doubts, that it belongs to this species. The following analysis, made by Mr. Chs. A. Kurlbaum will, show the correctness of his view.

B.B. it behaves like *a*; its composition is:

Silica,	40·15 per cent.	contains Oxygen,	20·86		= 2
Alumina,	20·77	" "	9·71		= 1
Oxyd of iron (FeO)	26·66	" "	5·92		
Oxyd of Manganese,	1·85	" "	0·42	10·09	= 1
Magnesia,	8·08	" "	3·23		
Lime,	1·83	" "	0·52		

12. *Allanite.*

Though we have already numerous analyses of this mineral, we are not yet arrived to a certainty with regard to its composition. This is owing to various causes, principally, I suppose, to the fact that analysts have in most cases not taken the necessary care to ascertain, whether the iron in allanites is in the form of oxyd (FeO) or in that of sesquioxyd (Fe_2O_3), or in both states of oxydation. At my request, Mr. Peter Keyser made a series of analyses of American allanites. The separation of the oxyds of cerium, lanthanum and didymium from iron and alumina in all the analyses (α) was made by sulphate of potash; in analyses (β) by oxalic acid; sesquioxyd of cerium was separated from lanthana and oxyd of didymium by very diluted nitric acid and the oxyd of iron by chlorid of gold and sodium. All the rest of the determinations were made in the usual manner.

a. Allanite from Orange county, N. Y.*—Massive, no cleavage could be detected; H. 5·5; Sp. gr. (at 17° Cels.) = 3·782; lustre

* This is the mineral of which I spoke in my note in the Am. Journ. of Sc., 2d Ser., vol. xvi, page 86.

resinous; streak gray; color pitch-black: opaque; fracture uneven—subconchoidal; brittle.

B.B. it fuses with intumescence to a black slightly magnetic glass. Dissolves easily in hydrochloric acid.

The analyses gave the following results.

	α		β	Mean.	Contains oxygen.	
Silica,	32·23		32·17	32·19	16·71	=16·71
Alumina,	11·99		12·00	12·00	5·61	= 7·51
Sesquioxyd of iron,	6·30		6·39	6·34	1·90	
Oxyd of iron,		10·55		10·55	2·34	
Oxyd of manganese,	0·51		not det.	0·51	0·11	
Oxyd of cerium,	15·28		15·45	15·37	2·22	
Lanthana, Oxyd of didymium,	8·79		8·89	8·84	1·29	= 9·18
Magnesia,	0·54		1·14	0·84	0·34	
Lime,	8·98		9·31	9·14	2·60	
Soda,		1·00		1·00	0·25	
Potash,		0·18		0·18	0·03	
Water,		1·19		1·19	1·06	= 1·06

b. Allanite from near Eckhardt's Furnace, Berks county, Pa.—In color, general appearance and its blowpipe reactions, resembles very much the allanite from Orange county.

H. = 6; Sp. gr. (at 27° Cels.) = 3·825–3·831.

The analyses gave the following results:

	α		β	Mean.	Contains oxygen.	
Silica,	32·97		32·81	32·89	17·07	= 17·07
Alumina,	12·40		12·59	12·49	5·84	= 8·04
Sesquioxyd of iron,	7·10		7·56	7·33	2·20	
Oxyd of iron,		9·02		9·02	2·00	
Oxyd of manganese,	0·25		not det.	0·25	0·05	
Oxyd of cerium,	15·79		15·56	15·68	2·27	
Lanthana, Oxyd of didymium,	10·17		10·02	10·10	1·47	= 8·46
Magnesia,	1·91		1·63	1·77	0·61	
Lime,	7·30		6·94	7·12	2·02	
Soda,		0·09		0·09	0·02	
Potash,		0·14		0·14	0·02	
Water,		2·49		2·49	2·21	= 2·21

It is found abundantly near Eckhardt's Furnace, Berks County, Pa., associated with quartz, zircon, mica and titaniferous magnetite.

c. Allanite from Bethlehem, Northampton county, Pa.—Massive; H. = 5; Sp. grav. (at 16° Cels.) = 3·491; lustre resinous; color brownish black; streak gray; opaque; fracture subconchoidal.

B.B. it decrepitates slightly and fuses with intumescence to an iron black magnetic slag. Hydrochloric acid dissolves it readily.

Occurs in a decomposed granite in flat pieces of not more than half an inch in thickness; their surfaces are covered with a crust of hydrated sesquioxyds of iron and cerium, etc., resulting from the decomposition of the allanite by the action of atmospheric water.

The results of the analyses were:

	a		β	Mean.	Contains oxygen.	
Silica, . .	33·36		33·27	33·31	17·30	= 17·30
Alumina, . .	14·54		14·13	14·34	6·70	= 9·95
Sesquioxyd of iron,	10·71		10·95	10·83	3·25	
Oxyd of iron, .		7·20		7·20	1·60	
Oxyd of cerium .	13.72		13·11	13·42	1·94	
Lanthana, Oxyd of didymium,	2·76		2·64	2·70	0·39	= 8·15
Magnesia, . .	0·95		1·52	1·23	0·68	
Lime, . .	11·27		11·28	11·28	3·21	
Soda, . .		0·41		0·41	0·11	
Potash, . .		1·33		1·33	1·22	
Water, . .		3·01		3·01	2·68	= 2·68

In the allanite from Orange county, the ratio of oxygen of $RO : R_2O_3 : SiO_2$, is equal to $1 : 0{\cdot}8 : 1{\cdot}8$, which is $= 5 : 4 : 9$, corresponding with the formula: $5\dot{R}_3\ddot{S}i + 4\ddot{R}\ddot{S}i$, the allanites of Reading and Bethlehem give very near the ratio $1 : 1 : 2$, corresponding with the formula $\dot{R}_3\ddot{S}i + \ddot{R}\ddot{S}i$.

The slight variation in the Orange county allanites of which the ratio of oxygen was found to be $= 5 : 4 : 9$ may be owing to small impurities of this mineral; I believe that, when pure, it has, like the two others, and like all allanites which have been examined with regard to the state of oxydation of the iron in them, the ratio $1 : 1 : 2$, or the constitution of garnet. The quality of water in the allanites, resulting in all probability from a change, beginning in the composition of this mineral, as previously suggested by Prof. Rammelsberg, was found to vary from 1·19 per cent. to 3·01 per cent.; but if we take it into consideration, the composition of the Orange county allanite may be expressed by the formula $2(\dot{R}_3\ddot{S}i + \ddot{R}\ddot{S}i) + \dot{H}$; that of the allanites from Bethlehem and Eckhardt's Furnace by $(\dot{R}_3\ddot{S}i + \ddot{R}\ddot{S}i) + \dot{H}$.

13. *Tungstates* in North Carolina.

Tungstates having been found only at two or three localities in the United States, it was interesting to find them in North Carolina at two localities, viz: Dr. Cosby's mine, near Pioneer Mills, Cabarrus county, (*a*, *b* and *c*,) and at the Washington mine, Davidson county, (*d*).

a. Wolfram occurs in irregular lamellar masses in brown hematite and in a hydrate of the sesquioxyds of iron and manganese, which appears to be a result of the decomposition of spathic iron. It is associated with scheelite, tungstate of copper, and sulphate of baryta.

b. Scheelite is found in white, yellowish white and brownish crystals and crystalline masses. The crystals are rough and very imperfect, but on one I could observe the planes P . 0P . P∞. They are sometimes more than half an inch in length. It occurs also in granular and compact masses.

c. Tungstate of Copper (? and Lime); a new mineral.—? Amorphous; massive and pulverulent; sometimes (if massive) of the lustre of wax, but usually dull; color between siskin and pistachio-green.

B.B. in a tube gives water and blackens; on charcoal it fuses with intumescence easily to an iron-black slag, containing globules of metallic copper; with fluxes it gives the reactions of copper and tungstic acid. Soluble in hydrochloric acid with separation of tungstic acid; the solution contains oxyd of copper and lime. I believe that the lime belongs to the constitution of this mineral, and is not owing to an admixture of Scheelite, with which it is associated, and that its composition is analogous to that of Volborthite, which it somewhat resembles, or a hydrated tungstate of copper and lime.

d. Scheeletine.—Only one lump of quartz, which had a few crystals of this very rare mineral upon it, was found at the Washington Mine, Davidson county, N. C.

The crystals are quadratic octahedra P, some also in combination with the plane ∞ P. The planes sometimes being curved, give the crystals a barley shaped appearance. Color lavender blue and yellowish white; lustre pearly—subadamantine; brittle.

B.B. with microcosmic salt in the reducing flame gives an azure-blue glass; with carbonate of soda upon charcoal metallic lead. It is associated with pyromorphite, brown blende, iron pyrites, etc.

14. *Scorodite.*

I am not aware that another locality has been observed in the U. S., except Edenville, N. Y. It occurs also, coating the cavities of quartz and brown hematite, associated with gray copper, copper and iron pyrites at Geo. Luderick's farm, Cabarrus county, N. C.

It is found there in aggregations of greenish white, brownish and leek-green crystals. Only rarely they are large enough to distinguish their form, which is a combination of the planes P . ∞ $\breve{P}2$. ∞ $\bar{P}$ ∞.

15. *Wavellite.*

This is another mineral of which only a few localities are recorded in the United States. I found it at the Washington Mine, Davidson county, N. C., in a talcose slate in globular concretions with a radiated structure, associated with actinolite, galena, blende, iron pyrites, silver, etc.

Correction.—In the article, Owenite identical with Thuringite, this Journal, last volume, p. 411, for Schmiedeberg read Schmiedefeld.

Philadelphia, Oct. 4, 1854.

ART. IV.—*On the Diamagnetic Force;* by Prof. TYNDALL.*

WITH regard to the character of diamagnetic force great diversity of opinion prevails. In Germany we have Weber affirming that diamagnetic bodies possess a polarity opposed to that of iron. Weber's countryman, Von Feilitsch, combats this opinion in a series of Memoirs recently published in Poggendorff's '*Annalen*.' He affirms that diamagnetic bodies possess a polarity the same as that of iron; and endeavors to bring the phenomena into harmony with this view. In this country, on the contrary, we have Prof. Faraday, and it was believed, Prof. Thomson, neither of whom are prepared to admit the existence of any polarity whatever on the part of diamagnetic bodies. These divergences were a sufficient proof of the difficulty of the subject, and the necessity of caution in dealing with it; the author, therefore, thought it well to commence with the fundamental phenomena, and ascending from them to the more complicated, to endeavor to obtain, by strict adherence to experiment, a clear insight as to the real nature of that force by which certain bodies are repelled by the poles of a magnet.

From an extensive series of experiments made with different bodies, and under the most diverse circumstances, the author selected a few which clearly exhibited the law according to which the repulsive force augments when the strength of the repelling magnet is increased. Were the repulsion of a diamagnetic body dependent on any constant property of the mass, then its repulsion must be simply proportional to the strength of the magnet; but it is proved by the concurrent testimony of experiments carried on in Germany, France, and England, that, for a wide range of magnetic power, the repulsive force increases as the square of the strength of the influencing magnet. This leads inevitably to the conclusion, that the repulsion of a diamagnetic body depends, not alone on the magnet operating upon it, but upon the joint action of the magnet and diamagnet. A piece of bismuth, for example, in presence of the magnet is thrown by the latter into a state of excitement, which varies as the magnetic strength varies, and in virtue of which the substance is repelled. The next question to be decided is, whether the state of excitement evoked by one pole, in a diamagnetic body, enables a pole of an opposite quality to repel it.

To decide this, two cores of soft iron were so bent, that the two semi-cylindrical ends of the cores could be placed close together, so as to form a single cylinder of the same diameter as that of the straight portions of the cores. The cores being placed in suitable helices could be so excited that the contiguous poles

* Proceedings of the British Association, 1854, Athenæum, Oct. 7.

were of the same or of opposite names. A bar of bismuth was freely suspended, so that both poles could act upon it simultaneously. When the cores were excited, so that the poles were alike, the bismuth was repelled; when the poles were of different names, the bismuth bar remained motionless; all action upon it was annulled. This experiment confirms those of Reich, and proves that the condition, whatever it may be, which is evoked by one magnetic pole is neutralized by the other,—that each particular pole evokes a condition peculiar to itself;—and here we obtain the first glimpse of the dual nature of the force under consideration.

The next portion of the inquiry treated of the deportment of diamagnetic bodies when acted upon, first, by the magnet alone; secondly, by the electric current alone; and, thirdly, by the current and the magnet combined. When we speak of the deportment of bismuth in any one of the cases mentioned, no exact meaning can be attached to the phrase unless it be first strictly defined in what direction, as to the planes of crystallization, the mass has been cut. A bar of bismuth, in which the planes of principal cleavage are parallel to the length of the bar, and acted upon by the voltaic current alone, will set itself parallel to the current's direction. A bar, on the contrary, in which the planes of cleavage are transverse, will set itself at right angles to the current's direction, The former bar Prof. Tyndall calls a normal diamagnetic bar; the latter an abnormal one. The most perfect antithesis is observed in all cases between the deportment of the normal diamagnetic bar and a bar of soft iron; the forces which cause a deflexion of the former from right to left produce a deflexion of the latter from left to right. If the former take up a position of equilibrium from southwest to northeast the position taken by the latter will be from southeast to northwest; and throughout all the experiments the same opposition of action is exhibited. By mechanical means, an abnormal magnetic bar was obtained—a bar which set its length at right angles to the line joining the poles. The abnormal diamagnetic bar shows throughout a deportment precisely antithetical to that of the normal magnetic one; but when we compare the normal magnetic with the abnormal diamagnetic, or the normal diamagnetic with the abnormal magnetic, the deportment is in all cases perfectly alike. It is evident, therefore, that unless the influence of structure be attended to, the greatest errors and the most inaccurate conclusions may be founded on the deportment both of magnetic and diamagnetic bodies in the magnetic field; but the thing which chiefly concerns us is the strong presumption which the experiments justify, that whatever be the nature of the influences evoked in magnetic bodies by the action of currents, or magnets, or of both combined, to an influence, of the same nature but an-

tithetical in its manner of distribution, the deportment of diamagnetic bodies is to be referred.

The next section of the inquiry imparted clearer knowledge as to the nature of diamagnetic action. Two helices were so placed that the ends of the soft iron cores which fitted into them were about six inches apart from centre to centre; the helices were at opposite sides of the plane which touched the ends of the cores. A helix of copper wire was introduced, and within it a bismuth bar 6½ inches long and four-tenths of an inch in diameter was freely suspended, so that the ends of the bar were opposite to those of the soft iron cores. A current being sent through the helix, if the bismuth bar within it were excited by the current it was probable that the nature of the excitement would manifest itself in the action of the magnets upon the diamagnetic body. By working delicately the most perfect mastery was obtained over the suspended bismuth; when the current through the helix flowed in a certain direction the ends of the diamagnetic bar were repelled by the electro-magnets; when the current flowed through, the helix was reversed, and the same ends were attracted by the magnets. The same effect was obtained when, instead of reversing the helix current, the polarity of the two magnets was reversed. On comparing the deflexions with those of soft iron, it was found that they were perfectly antithetical. The excitement which caused the ends of the iron bar to be attracted caused the ends of the bismuth bar to be repelled, while the excitement which caused the ends of the iron bar to be repelled caused those of the bismuth bar to be attracted.

All these experiments point irresistibly to the conclusion that, whatever the ideal magnetic distribution in iron may be, a precisely opposite distribution occurs in bismuth,—or, in other words, that the diamagnetic force is a polar force, but that the polarity is the reverse of magnetic polarity. If, however this be true, the bismuth bar, when the current circulates round it, must have its two ends in different states; but if in different states, then if we make the two poles acting upon the ends of the bar alike, we ought to have attraction at one end and repulsion at the other,—the result of their opposing actions being that the bar must remain undeflected. The decisive experiment has been made, and the result is in perfect accordance with the conclusion just expressed; when both magnetic poles are of the same name they completely neutralize each other. Following up this inductive reasoning, it is easy to see that, if what has been stated be correct, when we bring two magnets with poles of the same name to bear upon a bismuth bar, the direction of the force emanating from the two poles being the same, then the repulsion of one end and the attraction of the other, instead of, as in the former disposition, neutralizing each other, ought to constitute a mechanical couple

tending to deflect the bar; and if two other poles of the same name, but of opposite names to the former two, be caused to act upon the bar the force of deflexion ought to be increased. In this form the experiment was made before the Section. Four magnets were made use of; the two poles to the left were of the same name, and the two to the right were of the opposite quality. The result completely coincided with the author's anticipations, and the bar was promptly deflected.

These experiments, without any exception, are all corroborative of the view, that diamagnetic bodies possess a polarity opposed to that of magnetic bodies,—but they do not prove that the physical theory of Weber is correct. Indeed, it is scarcely possible that this theory can stand in opposition to the experimental evidence which can be brought to bear against it. One consequence of this truly beautiful theory is, that when the particles of a diamagnetic body are caused to approach each other, the effect of their approximation will be to enfeeble the magnetic action along the line of approach. This view is opposed by the most direct experiments, which prove that the approximation of diamagnetic particles has an effect precisely opposite to that deduced from the theory.

Prof. W. Thomson remarked, that as early as the year 1847 he had published in the *Cambridge and Dublin Mathematical Journal* for May of that year, a theory of the phenomena presented by diamagnetic bodies in the neighborhood of a magnet, in which it was assumed as the only possible explanation of the repulsions observed by Faraday, that magnetic force induces upon a fragment of bismuth or of any other diamagnetic substance a polarity reverse to that which a piece of soft iron experiences in the same circumstances. In that paper the same set of mathematical formulæ are applied to either ferromagnetic (paramagnetic as they are now called) or diamagnetic bodies; the sole difference between the two cases being that a certain co-efficient, which measures the inductive capacity of the substance, has positive values for all ferromagnetics, and negative values for all diamagnetics. Since the time when that Paper had been published, he never had either expressed or felt the slightest doubt as to the certainty of the explanation of the elementary phenomena of diamagnetics which it afforded. Some views, founded on the impossibility of a perpetual motion, such, as it appears, would result from the actual substance of a diamagnetic solid receiving by induction a state of magnetization the reverse of iron in the same circumstances, which had been brought forward by Prof. Thomson at the Belfast Meeting of the British Association, had been referred to as opposed to the theory of the polarity of bismuth.

Prof. Thomson explained that those views led to the conclusion, not that bismuth experienced no magnetic polarity, but that

the actual magnetization of its substance could not be the reverse of that of soft iron, and that the surrounding medium (whether it be air or what we habitually but falsely call vacuum) must experience magnetization similar to that of iron in the same position, and greater in degree than that of the bismuth. According to this conclusion, the definition of an ordinary diamagnetic is, a substance less magnetizable than air. Prof. Thomson further remarked, that he had not perfect confidence in the truth of this conclusion, as one of the assumptions on which the reasoning was founded admitted of doubt; but he had no doubt whatever of the resultant polarity of bismuth, however occasioned, being the reverse of that of iron. He concluded by expressing complete agreement with Prof. Tyndall on this point, and admiration of the remarkable combination of powerful and delicate apparatus, and the beautiful and well planned experiments by which Prof. Tyndall had so successfully demonstrated the antithesis between iron and bismuth to the Meeting.

ART. V.—*Reply to some remarks by W. H. Wenham, and Notice of a new locality of a Microscopic Test-object;* by Prof. J. W. BAILEY, U. S. Military Academy, West Point.

IN an article by W. H. Wenham, Esq., of London, published in the Quarterly Journal of Microscopic Science for July, 1854, I have noticed the following paragraph:

"These experiments [made by Mr. Wenham] will readily account for the difficulty of discovering the markings or structure of a severe test when mounted in balsam; for as thus seen it may be inferred that no aperture exceeding 85° can be made to bear upon it, and this is even supposing that the largest aperture object-glass that has ever been constructed is used. Such being the case I am somewhat puzzled at an announcement that appears to contradict this fact, coming from one that must be considered as authority in these matters. I refer to Professor Bailey, who, in a letter addressed to Matthew Marshall, Esq., dated January 20th, 1852, first speaks of an American object-glass of very large aperture (172½°) and its performance on the *most difficult tests known*, and then proceeds to say 'In all these cases (and in fact whenever I allude to a test-object) I mean the *balsam* mounted specimens. The *dry* shells I *never* use as tests.' This assertion seems to me to be extraordinary, and very like saying that an aperture of 85° or 90° will do every thing that is required. I have invariably found that when very difficult tests are mounted in balsam I cannot discover the markings, and certainly the reasons herein given will account for it. It is to be hoped that the American opticians have discovered some new and peculiar principle in

object-glasses, that will render a smaller amount of aperture serviceable; but however this may be, I think that Professor Bailey's statement requires some explanation."—*Journ. Mic. Science, July*, 1854, p. 215.

It is apparent from the above that Mr. Wenham has convinced himself, both by "reasons" and experiment, that I *ought* not to have seen the markings on delicate test-objects when mounted in balsam; and that as he invariably found that he could not discover these markings, therefore some new and peculiar principle in object-glasses must have been discovered to account for the success of American opticians. In answer to this I would state that both in print, as well as in private letters I stand fully committed to the statement that I can resolve the most difficult tests known *even when mounted in balsam*. In 1849 I stated in this Journal, vol. vii, p. 268, that "the resolution of these tests mounted *dry* is so much easier than when in balsam, that objects thus mounted are of little value in testing the powers of lenses, although they may answer well when the end is to make out the real structure of the object itself." In fact I have up to this time met with no object which, when mounted *dry* presents sufficient difficulty to rank as a severe test-object, while there are many which when balsam-mounted become very satisfactory.

It is certainly no duty of mine to explain why Mr. Wenham has failed in his attempts to resolve the balsam-mounted specimens, particularly as the resolution of such tests is a matter of every-day amusement with microscopists in this country, and I believe Mr. Wenham does injustice to the microscopists and microscopes of London, in representing the English glasses as incapable of doing as much. That the English lenses are capable of performing well on balsam-mounted objects of considerable difficulty I know by my own trials, some of which are referred to in the following paragraph from a paper recently published in the Smithsonian Contributions to Knowledge, vol. vii, p. 14. "I would here state that in the spring of 1853 I resolved the Greenport Grammatophora [balsam-mounted] unmistakably by a $\frac{1}{4}$ of an inch objective made by Spencer, and subsequently by a $\frac{1}{4}$ recently made by Powell of London for Dr. Vanarsdale of N. York."

As Mr. Wenham does not mention the names of the test-objects employed by him, I cannot say that they may not be more difficult than any known to me; yet I feel no hesitation in challenging him to produce an object resolvable when dry, which I cannot resolve when balsam-mounted. I will also state that I, at present know of no test-object more difficult than a supposed variety of Grammatophora stricta, *Ehr.*, from Halifax, N. S. This is as much more difficult than the Providence Grammatophora, as the latter is more difficult than the Greenport specimens. As a supply of the last two varieties has been in London for two years they are probably known to Mr. Wenham and may have been

subjected to experiments by him. That the balsam-mounted specimens of all these objects can be satisfactorily resolved is well known to American observers, and the following statement given by Judge A. S. Johnson in vol. xiii, p. 32 of this Journal, is fully confirmatory of my own experience. Speaking of a new object-glass of 174½° made in July, 1851, by Spencer, the following remarks are made:

"The light failing us as evening was approaching we did not try in this way either the Amici test or the Providence Grammatophora, but in the evening we saw both these objects [balsam-mounted] satisfactorily resolved into dots by unreflected oblique light from one wick of a common bed-chamber lamp, burning oil, a homely but very effective method of illumination for objectives of large apertures."

It appears then that the resolution of balsam-mounted specimens of difficult test-objects *can* be accomplished, in spite of Mr. Wenham's arguments and experience to the contrary. The error in his arguments will be sufficiently obvious to any one who will trace the course of a divergent pencil of rays *out of* the balsam instead of *into* it, as in Mr. Wenham's experiments, and it will then be seen that large angles of aperture are as useful for balsam-mounted specimens as for others. I leave the defense of large angles of aperture to the professed optician, being well satisfied that, notwithstanding the extraordinary attempts made by certain writers in England to underrate the value of the improvements made in this direction, no one who has once employed a properly corrected object-glass of large aperture will ever be satisfied with one of a different construction.

On a new locality of Microscopic test-objects.

In a Smithsonian memoir published in February, 1854,* I have described and figured a species of Hyalodiscus from Halifax, Nova Scotia, which appeared to me to be admirably fitted for a test-object, in as much as its circular form with radiant and curved lines of great tenuity proceeding in all directions renders it unnecessary ever to change the position of the shell when in the field of view in order to secure the best possible direction of the light. Whatever its position, on account of the perfect symmetry of its form and markings, some portion must always be in the best possible position with reference to the oblique light used for its examination. Unfortunately the Halifax specimens of this beautiful object appear to be quite rare, I am therefore happy to announce the discovery upon various Algæ from Monterey, California, of an inexhaustible supply of a species of Hyalodiscus closely allied to the Halifax species and answering equally well as a test-object. I find it so convenient as a test-object when *balsam-mounted* that I am sure it will find favor with lovers of the microscope.

* Notes on New Species and Localities of Microscopical Organisms, by J. W. Bailey, in Smithsonian Contributions to Knowledge, vol. vii, p. 14.

ART. VI.—*On the bearing of the Barometrical and Hygrometrical Observations at Hobarton and the Cape of Good Hope on the general theory of the Variations of Atmospherical Phenomena;* by Professor DOVE of Berlin.*

I HAD hoped to have prefaced this volume with a discussion of the meteorological observations made hourly at Hobarton from January, 1841, to September, 1848 (of which the abstracts were published in 1850 in the first volume of the Hobarton Observations), from the pen of Professor Dove, who had kindly undertaken, at the magnetical and meteorological conference at Cambridge in 1845, to participate to that extent in the reduction and application to theoretical conclusions, of the results of the Observations at the British Colonial Observatories; but M. Dove's appointment, on the death of Professor Mahlmann in November, 1848, to the charge of the meteorological observatories in the Prussian states has materially abridged the time at that gentleman's disposal, and he has found himself unable to complete the discussion he had undertaken for the present volume without occasioning an inconvenient delay in its publication; the discussion will therefore be prefixed to the fourth volume; but in the mean time Professor Dove has kindly furnished for this volume the subjoined remarks (written in German) upon the bearing which the barometrical and hygrometrical observations, at the Colonial Observatories at Hobarton and the Cape of Good Hope, have had on the general theory which professes to explain the physical causes of the variations which we observe in the atmospherical phenomena of the globe. The testimony borne by so eminent a meteorologist to the importance and value of this portion of the observations made at the British Colonial Observatories, cannot fail to be highly acceptable to the Government which instituted it, and to the public who have paid for these establishments, as it must be most satisfactory to the officers and to their assistants, by whose patient and unremitting labor facts of which the importance is thus recognized have been added to the foundations of meteorological science. The generalization in which M. Dove has applied them is remarkable alike for its extent and its simplicity, and I am glad of the opportunity of enriching this volume with so interesting a document. EDWARD SABINE.

Woolwich, March 17, 1853.

The establishment of meteorological stations in distant parts of the globe had, generally speaking, for its immediate object, so to complete the partial knowledge we already possessed of the phe-

* From "Observations made at the Magnetical and Meteorological Observatory at Hobarton, in Van Dieman Island," vol. iii, Introduction.—Phil. Mag., Oct., 1854.

nomena over a considerable portion of its surface, as to enable us to take a general view of their course over the whole globe; the result of those endeavors has even exceeded what was hoped for, as besides the information obtained respecting regions where our knowledge was most defective, fresh light has been thrown on those with which we had supposed ourselves already completely acquainted.

Meteorology commenced with us by the study of European phenomena, and its next principal extension was to phenomena observed in the tropical parts of America. If what is true of Europe were equally true of the temperate and cold zones of the earth in all longitudes, and if tropical America in like manner afforded a perfect example of the tropical zone generally, it would be of little consequence where the science of meteorology had been first cultivated; but this is not the case, and a too hasty generalization has led to the neglect of important problems, while others less important have been regarded as essential and placed in the foremost rank. It was necessary that the science should be freed from these youthful trammels, and this needful enfranchisement has been effected by the Russian and by the English system of observations. Russia has done her part in freeing the meteorology of the temperate and cold zones from impressions derived exclusively from the limited European type; and England, which by its Indian stations had undertaken for the torrid zone the same task of enlarging and rectifying the views previously entertained, has besides, by its African and Australian stations (Cape of Good Hope and Hobarton), opened to us the southern hemisphere, and first rendered it possible to treat of the atmosphere as a whole. I will now endeavor to show the importance of being enabled to take such general views, selecting as an example the annual variation of the barometer.

The study of the *annual* barometric variation had long been singularly neglected, while the *diurnal* barometric variation had had devoted to it an attention quite disproportioned to its subordinate interest in reference to the general movements of the atmosphere. This otherwise incomprehensible mistake is excused by the localities where nature had been first interrogated. As the diurnal variation had manifested itself with great distinctness and regularity in tropical America, it naturally presented itself as an object of interest in Europe also. The annual variation, on the other hand, is inconsiderable, both in Europe and the tropical parts of America; and thus, while atmospheric phenomena were treated simply as facts of which the periodicity alone was to be investigated, without seeking for physical causes, it was natural that a phenomenon, in which opposite effects resulting from two different causes counterbalance each other, should altogether escape notice. It is, perhaps, more remarkable that no surprise

should have been excited when the atmospheric pressure was not found to diminish from winter to summer, with increasing heat.

When, by the labors of Prinsep more particularly, the phenomena of the tropical atmosphere in Hindostan became more known, there was seen to be a great difference between the barometric variation there and in tropical America; inasmuch as the Indian observations showed a decidedly well-marked annual variation. A new error was now fallen into, and it was supposed that the phenomenon did not extend beyond the torrid zone, and that it was an immediate consequence of the periodical change of wind, *i. e.* of the monsoons. This erroneous view was completely refuted when the barometric relations at the Siberian stations became known; for it was then found, that north of the Himalaya (which in the supposed hypothesis must have formed the limit of the phenomenon), the annual barometric variation was exhibited on a large scale, and over a region so extensive, that the shores of the Icy Sea itself could hardly be assumed as its boundary. A greatly diminished atmospheric pressure taking place in summer over the whole continent of Asia must produce an influx from all surrounding parts; and thus we have west winds in Europe, north winds in the Icy Sea, east winds on the east coasts of Asia, and south winds in India. The monsoon itself becomes, as we see, in this point of view only a secondary or subordinate phenomenon.

I have endeavored to establish the reality of the above phenomenon and its climatological bearings in several memoirs; and I must refer for the numerical values to Poggendorff's *Annalen*, vol. lviii, p. 177; vol. lxxvii, p. 309; and to the *Berichte* of the Berlin Academy, 1852, p. 285. I will here embody the results in distinct propositions, in order to show, in connexion therewith, the importance of the bearings of the Hobarton observations.

1. At all stations of observation in the torrid and temperate zones, the elasticity of the aqueous vapor contained in the atmosphere increases with increasing temperature. In the region of the monsoons this increase from the colder to the warmer months is greatest near their northern limit. Hindostan and China present in this respect the most excessive climate. No differences of similar magnitude are found in the southern hemisphere. The form of the curve of elasticity of the aqueous vapor shows, however, a less decidedly convex summit in the region of the monsoons than beyond it, having in that region rather the character of a flattened summit or table-land, the elasticity continuing nearly the same throughout the period of the rainy monsoon. Near the equator the convex curve of the northern hemisphere becomes, first flattened, and then gradually transformed into the concave curve of the southern hemisphere. In the Atlantic this transition takes place in a rather more northerly parallel. In regard to the magnitude of the annual variation, the following rule

appears generally applicable in the torrid zone: the annual variation is considerable at all places where equatorial currents prevail when the sun's altitude is greatest, and polar currents when the sun's altitude is least; and inconsiderable wherever the direction of the wind is either comparatively constant throughout the year, or where it changes in the contrary sense to that above described. At the last-named class of places the rate of decrease in the mean annual tension of the aqueous vapor with increasing distance from the equator is more rapid than in the first class.

2. At all stations in Europe and Asia the pressure of the dry air decreases from the colder to the warmer months, and everywhere in the temperate zone has its minimum in the warmest month.

3. If we compare the annual variation of the pressure of the dry air in northern Asia and Hindostan with the variation in Australia and the Indian Ocean, we shall be satisfied that something more takes place than a simple periodical change of the same mass of air in the direction of the meridian, between the northern and southern hemispheres. From the magnitude of the variation in the northern hemisphere, and the extent of the region over which it prevails, we must infer that at the time of diminished pressure a *lateral* overflow probably takes place; that it actually does so may be considered as proved for the northern part of the region, by the fact that at Sitka, on the northwest coast of America, the pressure of the dry air *in*creases from winter to summer. It is not probable that the overflow takes place exclusively to the east, it probably occurs also to the west; and on this supposition the small amount of the diminution of the pressure of the dry air from winter to summer in Europe would be caused, not solely by the moderate amount of the difference of temperature in the hotter and colder seasons, but also by the lateral afflux of air in the upper regions of the atmosphere tending to compensate the pressure lost by thermic expansion. As at the northern limit of the monsoon, at Chusan and Pekin, the annual variation of the pressure of the dry air is most considerable, while at the northern limit of the trade wind in the Atlantic Ocean, *i. e.* at Madeira and the Azores, it is very small, it is probable that there is in the torrid zone also a lateral overflow in the upper strata of the atmosphere from the region of the monsoons to that of the trades.

4. From the combined action of the variations of the aqueous vapor and of the dry air we now derive immediately the periodical variations of the whole atmospheric pressure. As the dry air and the aqueous vapor mixed with it press in common on the barometer, so that the upborne column of mercury consists of two parts, one borne by the dry air, the other by the aqueous vapor, we may well understand that as with increasing tempera-

ture, the air expands, and by reason of its augmented volume rises higher and at its upper portion overflows laterally,—while at the same time the increased temperature causes increasing evaporation, and thus augments the quantity of aqueous vapor in the atmosphere,—so it naturally follows that the composite result in the periodical variations of the barometric pressure should not everywhere bear a simple and immediately obvious relation to the periodical changes of temperature. It is only when we know the relative proportions of the two variations which take place in opposite directions that we can determine whether their joint effect will be an increase or a decrease with increasing temperature,—whether in part of the period the one variation may preponderate and in other parts the other variation. The following are the results which we are enabled to derive from observation.

5. Throughout Asia, the increase in the elasticity of the aqueous vapor with increasing heat is never sufficient to compensate the diminished pressure of the dry air, and the annual variation of barometric pressure is therefore everywhere represented in accordance with the variation of the pressure of the dry air, by a simple concave curve having its lowest part or minimum in July. The observations in Taimyr Land, at Iakousk, Udskoi and Aiansk, show that this is true up to the Icy Sea on the north, and to the sea of Ochotsk on the east. On the west a tendency towards these conditions begins to be perceived in European Russia in the meridian of St. Petersburg, and becomes more marked as the range of the Ural is approached. On the Caspian and in the Caucasus the phenomenon is already very distinctly marked; its limit runs south from the western shore of the Black Sea, so that Syria, Egypt and Abyssinia fall within the region over which it prevails. Towards the confines of Europe there is almost everywhere a maximum in September or October, the barometric pressure increasing rapidly from July to the autumn. This maximum is followed towards the latter part of the autumn by a slighter inflexion or secondary minimum; it is only beyond the Ural that the curves become uniformly concave, with a single summer minimum and winter maximum, which character they retain throughout the rest of the Asiatic continent, even to its eastern coast. In winter the absolute height of the barometer at the northern limit of the monsoon is very great. The still considerable amount of the annual variations at Nangasaki, and the little difference between the curve of Manilla and that of Madras, show that the region in question extends beyond the eastern coast of Asia into the Pacific Ocean; in higher latitudes, however, its limits appear to be reached in Kamschatka. As the annual variation, which is greater at Madras than at Manilla, is found greater at Aden than at Madras, the western limit of the region would appear to extend far on the African side.

6. In middle and western Europe the barometric pressure appears to decrease everywhere from the month of January to the spring, usually attaining a minimum in April; it then rises slowly but steadily to September, and sinks rapidly to November, when it usually reaches a second minimum. In summer, therefore, the whole atmospheric pressure gains more by increased evaporation than it loses by expansion. This over-compensation is probably to be explained, as we have seen above, by the lateral overflow received in the upper regions from Asia. In Sitka the whole annual curve is convex, a result only found in Europe at considerable mountain elevations, where it is a consequence of the expansion, and extension upwards, of the whole mass of the atmosphere in summer.

7. The region of great annual barometric variation, on the Asiatic side of the globe where *monsoons* prevail, extends much further to the north in the northern hemisphere, than it does to the south in the southern hemisphere; for the variation reaches its maximum at Pekin, while at Hobarton, in nearly a corresponding latitude, it has already become inconsiderable; and it is generally greater in the northern than in the corresponding southern latitudes. The exact contrary is the case on the Atlantic side and in the region of the *Trades;* for here the annual variation, though nowhere very considerable, is decidedly greater in the southern than in the northern hemisphere, as is shown by the results of observation at the Cape, Ascension, St. Helena, Rio Janeiro, and Pernambuco, compared with the West Indian Islands and the southern parts of the United States. Hence it follows, that if we compare places in the same latitude, we find but little difference between the annual variation in the southern Atlantic and southern Indian oceans, while in the northern hemisphere we have in the same latitude the very large annual variation in the north part of the Indian and in the Chinese seas, and the almost entire absence of annual variation in the Atlantic (compare Chusan with the Azores and Madeira). The explanation of the last named phenomenon, *i. e.* that of the northern hemisphere, by a lateral overflow in the upper parts of the atmosphere, seems so direct, that I think we may pronounce the irregular form of the annual barometric curve in the West Indies to be a secondary phenomenon, the primary causes of which must be looked for on the east.

8. It is known that in the eruption of the Coseguina on the 20th of January, 1835, when the isthmus of Central America was shaken by an earthquake, not only were volcanic ashes carried to Kingston in Jamaica, a distance of 800 English miles in the opposite direction to the trade wind, but some of the same ashes also fell 700 miles to the *westward*, on board the Conway, in the Pacific Ocean. We infer, therefore, that in

the higher regions of the atmosphere in the tropics the air is not always flowing regularly from S. W. to N. E., but that this usual and regular direction is sometimes interrupted by currents from east to west. I think I have indicated the probable cause of such anomalous currents in the above described barometric relations of the region of the monsoons compared with that of the trades. If we suppose the upper portions of the air ascending over Asia and Africa to flow off laterally, and if this takes place suddenly, it will check the course of the upper or counter current above the trade wind, and force it to break into the lower current. An east wind coming into a S. W. current must necessarily occasion a rotatory movement, turning in the opposite direction to the hands of a watch. A rotatory storm moving from S. E. to N. W. in the lower current or trade, would in this view be the result of the encounter of two masses of air impelled towards each other at many places in succession, the further course of the rotation (originating primarily in this manner) being that described by me in detail in a memoir "On the Law of Storms," translated in the Scientific Memoirs, vol. iii, art. 7. Thus it happens that the West India hurricanes and the Chinese typhoons occur near the lateral confines on either side of the great region of atmospheric expansion, the typhoons being probably occasioned by the direct pressure of the air from the region of the trade winds over the Pacific into the more expanded air of the monsoon region, and being distinct from the storms appropriately called by the Portuguese "Temporales," which accompany the outburst of the monsoon when the direction of the wind is reversed. The fact of the rotatory storms being of much more rare occurrence in the South Atlantic Ocean arises from the more equal distribution of the periodically diminished atmospheric pressure in the southern as compared with the northern hemisphere. Here, therefore, the rotatory storms take place principally in the monsoon itself.

9. It is evident that the unsymmetrical distribution of land and sea, which gives rise to the abnormal variations in the forms of the isothermal lines, is at the same time the principal cause of the movements of the atmosphere. Thus the monsoon is but a modification of the trade wind, of which the cause is to be sought in part beyond the tropic. The region of great thermic expansion of the air in summer in the interior of the continent of the Old World presents all the characteristic marks of the region of calms, being a centre towards which all adjacent masses of air are drawn. Hence there is no complete sub-tropical zone, in the sense of a zone encompassing the globe. The region over which the heated air ascends does not therefore move up and down, or north and south, parallel with the sun's change of declination, but has rather a kind of oscillatory movement, in which the West Indies represent the fixed point, and the greatest ampli-

tude of oscillation is on the side of India. The northern excursion is much greater in the northern hemisphere than is the southern excursion on the side of the southern hemisphere. The European atmospheric relations, especially in summer, are therefore essentially of a secondary nature; and we must regard the little alteration in the atmospheric pressure in the course of the year in Europe as a secondary result, of which the explanation would not have been possible without the observations from Asia and Australia.

Berlin, January 5, 1853.

ART. VII.—*On the Composition of Eggs in the series of Animals*—PART I. By A. VALENCIENNES and FREMY.*

ANATOMISTS who undertake new researches on the eggs of animals, are obliged, while extending their investigations to the different species of the animal series, to recur to the periods, now distant, of the publications of Prevost and Dumas, and of Charles Ernest Baër. The discovery of the former confirmed the opinions of William Cruikshanks, founded on observations and exact experiments; and that of M. Baër, who succeeded in seeing the first rudiments of the ovule, even under the stroma of the ovary of mammals, made one step more in Ovology.

That distinguished anatomist, while aiming to follow the evolution of the fœtus, not only in the eggs of animals of that class, but in the different members of the animal kingdom, did not attempt to ascertain the nature of the liquids, more or less dense, of the egg, nor of those bodies held in suspension or dissolved in these liquids.

The same direction was pursued by those anatomists who have treated this subject before and after M. Baër. We should digress too much if we were to give a history of their successful labors. We believe it useful however to recall the course followed by the clever anatomist of Kœnigsberg and by his successors, in order to explain how it is that no one has yet investigated what the microscope has discovered in the vitellus (the yolk) of different eggs. It seems to us beyond a doubt that M. Baër saw the granular yolks of different kinds of ray fish and sharks, without studying them in detail. He did not try to discover their real nature by the aid of chemical analysis. He limited himself in fact, to saying that the yellow consists of a viscous liquid, of colorless grains of albumen, and of fat almost always divided into minute drops. This yellow is surrounded by white, but M. Baër did not try whether it would coagulate

* Translated from the Journal de Pharmacie, &c., May, 1854, p. 321, by Dr. J. Rosengarten, for this Journal.

like that of the egg of a chicken. In a word, this investigator saw in the eggs of these cartilaginous fishes, and in those of other animals, a mixture of principles as in the eggs of birds, always consisting of a yolk or vitellus, covered with white liquid albumen, and all contained in an external membrane as much varied in its nature as in color. We have reason for believing too, that M. Vogt perceived some vitellin grains in the yolk of the toad, Palytes obstetricans, *Dum.* He is however, less precise than M. Baër. It is also believed that M. Strauss saw the vitellin granules, of which we shall speak in our second paper, since he described in his beautiful work on the anatomy of the cockchafer, the yolk of eggs of these Coleoptera, as formed of a liquid pulp, composed of granules, and showing on the surface of the envelop of the egg a layer of globules. There are allusions to these granules in the work of Baudrimont and Martin Saint-Ange, which was crowned by the Academy of Sciences. But these authors did not separate them from the rest of the yolk to make them the subject of special study; they pointed them out in the midst of the drops of oil which swim in the yellow of the eggs of frogs. Other naturalists who have studied the eggs of different Annelids, Helminths, Insects, Arachnids, Crustacea, Molluscs (either Cephalopods, Gasteropods or Acephalous), speak of globules, without distinguishing them from drops of fat, and, which is more important for the subject of this article, without marking any vitellin substance.

M. Dumas and Cahours were the first who clearly distinguished in the egg of a hen, a particular proximate principle, the yolk, characterised by its physical properties and by its composition as deduced from chemical analysis. Their researches were not pushed further, and they were satisfied by calling by the same collective name of egg, all the products of the ovary that serve in any animal, after its fecundation, for the reproduction of individuals like the parent animal which secreted them.

On examining attentively the eggs of numerous oviparous animals, anatomists however have observed marked differences, which prove that these reproducing bodies are as varied as the animals to which they give birth. Thus,—only to cite a few facts,—the absence of the allantoid in the eggs of oviparous animals living in the water, was long ago remarked; the want of chalazes, the thin vitellin membrane detected with difficulty under the microscope taking its place; and as, one of us has observed, many kinds of eggs do not harden by cooking in boiling water.

The Academy long ago acknowledged the necessity of calling the attention of men of science to the investigation of this subject, by proposing to the meetings, questions relating more or less definitely to the particular composition of eggs. It has been fortunate to find in many communications addressed to it, a portion of the desired answers.

Feeling ourselves the importance of making additions to the researches already brought forward on the composition of eggs, we have undertaken this task together, the questions which it raises being partly zoological and partly chemical.

A subject so vast, which needs the continuous study of eggs of animals belonging to different classes of the animal kingdom, cannot be exhausted in one article; we are far too, from considering our researches as completed.

We propose in this memoir, to describe the differences which exist in the composition of eggs, and to lay down some general principles, to be developed in subsequent communications.

1. *Eggs of Birds.*

What we have said at the commencement of this article sufficiently explains our silence as to the composition of hen's eggs during the evolution of the fœtus, and as to former researches relative to the membranes which envelop the first formation of the chicken within the egg. We will here examine only the nature of the two substances, the white or albumen, and the yellow or vitellus, in order to start from this point of comparison in studying the eggs of other animals. We shall not follow strictly the order established by zoologists for the animal series, though we shall not depart widely from that order.

The composition of birds eggs has been clearly established by numerous authors, first by Vauquelin, Bostock, and then by Chevreul, John, Dumas and Cahours, Lecanu, Gobley, Martin St.-Ange and Baudrimont, Scheerer. And in this part of our researches, we are satisfied to confirm the exactness of the leading facts announced by the observers we have cited, and to determine with precision the specific characters of birds eggs.

The white of birds egg is considered by almost all chemists as a principle itself pure, though this white has in it various salts and a sulphurous body which can be separated from the albumen by different reagents without producing the decomposition of that substance, as was long ago shown by Chevreul.

In examining the white taken from eggs of different kinds of birds, we have often noticed that this body has varying properties. In some kinds, it is almost fluid; in others, it possesses a gelatinous consistency. The white of the egg of a hen is, after boiling, opaque, and of a pure color, white and solid. That of the lapwing becomes after cooking, transparent, opaline, greenish, and so hard that it may be cut into little stones, used in certain parts of Germany for common jewelry.

These peculiarities are not enough to prove that the white of birds eggs is formed of different albumens, but they seem to show that attentive researches will enable us to point out new properties in these albumens, which have hitherto escaped chemists.

When endeavoring to follow in another paper certain of the modifications which are produced in the egg during incubation, we shall then return to the peculiarities which relate to the constitution of albumen, and we shall examine, while supported by the labors of M. Chevreul, whether soluble albumen is to be taken as a pure proximate principle or not.

The yellow of a bird's egg is formed of a viscous liquid, holding suspended in it a fatty phosphuretted matter which shows some analogy to the cerebral fat. The viscidity of this liquid is due to the presence of an albuminous substance which has been carefully studied by Dumas and Cahours, and which chemists call *vitellin*. Vitellin is always found in the yellow of a bird's egg, associated with a certain quantity of albumen. The presence of albumen in the yolk of birds led us to modify the process which up to this time has been used in preparing vitellin. This material was obtained by drying with ether the yolk of a hen's egg previously cooked. To prepare vitellin, we treat the yolk of a hen's egg with cold water: the albumen is left dissolved in the water, while the vitellin is precipitated. The latter, washed with water, alcohol and ether, is nearly pure vitellin. While this substance thus obtained shows all the characteristics which have been marked by Dumas and Cahours, it offers so great analogy to albumen, that the presence of a certain portion of the latter substance does not sensibly modify its composition and properties. In this way we have proved that vitellin entirely freed from albumen, dissolves like albuminous substances, in boiling hydrochloric acid, producing a beautiful violet-blue color.

The yellow of a bird's egg exposed to damp air grows hard quickly, because the atmospheric moisture acting on the yolk, causes the precipitation of the vitellin; this solidification is first observed on the surfaces of the liquid which are in contact with the air. While examining the properties of the albuminous body which characterises the yolk of bird's eggs, and which has received the name of vitellin, we must first point out the resemblance between it and fibrine. The elementary analyses of these two substances give the following results:

	Fibrin.	Vitellin. I.	Vitellin. II.
Carbon,	52·5	52·26	51·60
Hydrogen,	7·0	7·24	7·22
Azote,	16·5	15·08	15·02
Oxygen and Sulphur,	24·0	25·42	26·16
	100·0	100·00	100·00

Vitellin and fibrin may be said to have the same composition; for with two bodies of this kind, uncrystalline, insoluble in water, and which consequently are purified with difficulty, what chemist can answer, in an organic analysis, for the one-hundredth part of azote? As to the chemical properties of these two bodies, it

should be remembered that they are almost identical. They are in fact, equally soluble in the alkalies; hydrochloric acid dissolves them alike, producing the characteristic blue. Before considering vitellin and fibrin as identical, we ought to submit vitellin to a test which in an unequivocal manner characterises fibrin. We know, after Thenard's beautiful observations, that fibrin has the property of decomposing oxygenated water and disengaging oxygen, like metallic oxyds; the azote obtained from the yellow of egg, should decompose oxygenated water, like fibrin, if it were identical with the latter. This experiment, made several times, has always given a negative result. Hence the azote-matter which exists in the yellow of bird's eggs, and which is precipitated when the yolk is diffused in a considerable amount of water, presents, it is true, an evident analogy to the fibrin of blood, but still differs from it in certain characteristics.

Reviewing the facts as to bird's eggs, established by us or by earlier observers, we may say, that aside from all the zoological and anatomical characters of the shell, its form and its varied color, the membranes, those formed at the moment of laying the egg or those which are developed during incubation,—the two essential constituents, prepared by nature to nourish the chick in the egg, may always be known by the following characteristics.

1st. The white, very rich in albuminous matter, is plainly separated from the yellow by the vitellin membrane.

2d. The yellow, principally made up of phosphuretted fatty matter, of a little albumen, of different salts, gives an abundant precipitate of vitellin when suspended in enough water. This substance, perfectly characteristic of birds eggs, is not met with in any other kind of eggs.

2. *Eggs of Fishes.*

The extensive family of fish with cartilaginous skeletons, the "Plagiostomes" of M. Duméril, has been divided by recent ichthyologists into many families. The Ray of Linnæus and of Lacépède constitute the family Raiidæ; the torpedos or electrical fish constitute the family Torpedinæ; the race of sharks subdivided into many others, is now the family Squalidæ. In the comparative study of these three families in connection with ovology, there are found fishes which are oviparous and ovoviviparous. We have mentioned the researches of M. Ch. Ern. Baër on the nature of the liquids contained in the egg of the Cartilaginæ, where he saw granules which he took for corpuscles of albumen. But beyond proving that these grains are different in substance from albumen, neither he nor other anatomists have yet studied the nature of the white or of the yellow of the eggs of these Cartilaginæ. This it is which we have attempted.

Of the Eggs of the Ray.—The new laid egg of a Ray is covered with a shell of a bronzed green, whose tissue is made up of short felty (feutrées,) fibres; its general form is a rectangle, more or less elongated and curved on both sides; each angle is prolonged in a crooked tongue (languette). The longer side of this rectangle extends into a very fine yellowish membrane, which looks like the shell. Carefully taking the egg out of the oviduct, the membranes are seen secreted in the interior of the great white gland which encloses the origin of the oviduct. The surface of each of them distended under water, is more than twice that of the shell.

In opening this egg, there is a good deal of yellow contained in a transparent gelatinous mass which represents the white of a hen's egg, although it is entirely different. The yellow is in the middle of this mass, in one of the transparent cells of the white, for the yolk, as M. Baër has very rightly said, has not a vitellin membrane of sûfficient strength to be observed under the microscope, and still less to separate the yellow from the white, so as to isolate it. So that in order to get the yellow matter entirely pure, it must be taken in an ovula nearly ready to detach itself from the ovary and to enter into the oviduct. We may now remark that this gelatinous white portion does not at all resemble the white of birds eggs: it does not dissolve in water, it does not either under the action of heat or acids, coagulate comparably with that of ordinary albumen. Examining this jelly carefully, we have seen that it was formed by vesicles, whose elastic membranes contain a liquid, which dissolved, showed only traces of albumen. When these vesicles are exposed to the air for several days, they become empty, as it were, losing their gelatinous consistency, and then produce a slightly albuminous liquid which holds suspended some transparent membranes. Alcohol equally destroys the gelatinous mass by stopping the coagulation of the membranes. Evaporating the white of the Ray's egg in vacuo, it is seen that it contains only traces of organic substances. The white of a Ray's egg, then, proportionably small compared with the yellow, is different in all its relations from the albumen of birds eggs.

The study of the yellow of the Ray's egg ought to establish differences still more remarkable between birds eggs and those of cartilaginous fishes. The yellow of the Ray's egg, under the microscope, shows that it is formed of a rather fluid liquid, holding suspended drops of a fatty body of light yellow, and a considerable quantity of small white transparent grains of a regular form. We have examined these grains in the different sorts of Ray-fish which abound in our Paris markets.

Eggs of the Torpedo.—We have examined many torpedos from the shores of La Rochelle, through the kindness of Dr.

Sauvé, a physician of that city. We have discovered that these fish, while like the Ray in general form, have quite another mode of generation, and in this respect, more nearly resemble the larger number of Sharks. Torpedos are ovoviviparous. We found in the oviducts of one, eight small ones, four on each side. Each fœtus when nearly born, had in the interior of the abdomen, a considerable portion of its vitellus (yolk). We were able to examine this liquid, and we found in it, with the microscope, grains similar in appearance to those in the Ray's eggs, though their forms were distinct. This is the only part of the Torpedos' egg we are as yet acquainted with. We cannot therefore say anything of the white of the eggs of this species of Cartilaginæ and of their shell.

Eggs of the Bounce Shark, (Catulus major, &c.)—The eggs of our Bounce are rectangular, much longer, but much narrower than those of the Ray. Its shell is hard, resisting, yellowish, horny, like the filament which starts from each angle. One is usually found in each oviduct, as in our Ray, to which another soon succeeds, after the laying of that which is completed in the belly of the female. The ovary of the Bounce, narrower than that of the Ray, is like it also in its structure; and under its stroma, there is a greater or less number of ovules of very different sizes, from those which are hardly perceptible to those vitellin spheres ready to detach themselves from the ovary to enter the oviduct. In opening an egg, the vitellus appears to occupy the greater part. Its vitellin membrane is even more difficult to see than that of the Ray: the white is more viscous, the membrane containing it much more delicate; the liquid, however, only contains some traces of albumen. Alcohol produces similar destruction of the gelatinous mass, stopping the coagulation of these membranes. The white of an egg of a Bounce is therefore very much like that of an egg of a Ray. The yellow of this egg resembles very considerably that of a Ray's egg. The very fluid liquid which composes it, holds suspended drops of yellowish oil, and a quantity of little white transparent grains, regular in form, but differing from that of the grains of the different sorts of Rays which we have examined.

Eggs of "Melandres," (Squalus galeus, *Lin.*)—If the Bounce shows the same ovological condition as the Ray, other sharks are like the torpedos, for they are, like these, ovoviviparous. We found in these eggs, by the microscope, a large quantity of little grains of a different form from that of our Ray, but still visibly analogous.

Eggs of the Round-Fish, (Squalus mustelus.)—Another sort of shark, the Emisole (Squalus mustelus, *Lin.*) gave us quite a number of ovules; for gestation was not far enough advanced to engage the eggs in the oviduct. This fact, fortunate for our

labor, showed us that the yellow of the eggs of sharks, still in the ovarian capsules, offers the same composition as those of Ray's eggs. Our observations are then established wholly by comparison.

Eggs of the Angel-fish, (Squatina angelus, *Dum.*)—We were not able to obtain more than one female this year, and all its ovules were still in the ovarian capsules, under the stroma of the ovary, which, in form, texture and even color, is more like those of the Ray than the sharks. We carefully gathered the yolks about to develop; we found in them, as in the former, a fatty matter divided into drops, swimming in a viscous albuminous liquid, with a great number of grains of peculiar form.

3. *Of Ichthin.*

Our observations on the eggs of so varied species and kinds of Cartilaginæ, bring us to the immediate analysis of the different yolks. After ascertaining that the grains suspended in the liquid were insoluble in water, and that this liquid did not thicken with water, the next step became very simple.

After taking proper precautions for running the yolk without mixing, into a large quantity of distilled water, the grains, which were denser than the water, fell to the bottom, and were washed by decantation, till the washing-water had no more trace of albumen or of salty matters. The grains were entirely freed from the fatty matter by successive washings in alcohol and ether. There remained after this treatment, a large quantity of grains, from which it is easy to get in some hours, several hundreds of grammes, which present under the microscope, every characteristic of absolute purity.

The analysis which we will now briefly describe, then showed us that the vitellus of an egg of the Cartilaginæ is formed of an albuminous liquid, holding in solution some mineral salts, principally chlorids and phosphates, and suspended white grains of an even and regular form in each species but varying in one species from another, and mixed with a small quantity of phosphuretted fat. This fatty matter is soluble in alcohol and ether; it forms with water a sort of mucilage; it shows some analogy to the fat-acid which is found in the stag, described by one of us as oleophosphoric acid. As for the white grains, they seem to us to constitute quite a new principle, whose properties and composition we shall describe as ichthin. Ichthin is pleasant to the touch, and presents to a certain extent, the aspect of starch. We obtained it by our process, pure, under the form of granules from different species of Cartilaginæ.

From the Thornback or Clavated Ray (Raia clavata, *Lin.*), the grains of ichthin obtained from the yolk of a freshly laid egg, appear in the form of little rectangular tables, with round edges

and obtuse angles; the largest are four hundredths of a millimetre, perfectly transparent, but distinctly marked edges. They are identical in the yolks in the process of formation, and in the ovarian vesicles, and whatever the size of these ovules from those which are only $0^{m}{\cdot}01$ in diameter, to the largest which are $0^{m}{\cdot}03$. In the smaller ovules with diameter varying from $0^{m}{\cdot}001$ to $0^{m}{\cdot}005$, the grains have the same tabular shape ("en tablettes,") but they were much smaller, and did not exceed two hundredths of a millimetre in length. Generally these grains are of one dimension in each ovule. But the differences we are about to point out, show that the grains enlarge with the development of the ovules, and that the vitellus, when they are little developed, has much smaller grains of ichthin than with those which are nearer the oviduct or more in the egg. The Ray from which these yolks were taken were hardly $0^{m}{\cdot}50$ long not counting the tail, with a weight of 4 or 5 kilogrammes. In our many examinations of different grains of ichthin, we met occasionally with some little tables almost square, others regular or irregular pentagons; these grains have a tendency to separate. We have not yet been able to see whether these different forms are due to some constant cause, or whether they are owing to simple accidental variations, so common in even the most elementary natural productions. We tried to crush these grains in an agate mortar, and found that generally they break according to the axes of the rectangles of these 'tablettes,' and not according to their diagonals. We studied the grains of yolk developed in the largest of our Ray such as in our markets go under the name of the soft or white Ray. This is the Raia oxyrhynchus of Linnæus. We must not forget to remark that individuals of this kind of Ray are even two metres long, not counting the tail, that they attain the weight of 100 kilogrammes, and yet the eggs of this Ray give the smallest grains of ichthin. Those of the spiked Ray (Raia fullonica,) and those of "la raie ronce" (Raia rubus,) are very much like those of "la raie bordée;" the most noticeable difference consists in their smaller dimensions. The largest are only three hundredths of a millimetre. In the eggs of these two sorts of Ray, the grains are very often regular ellipses, but the rectangular form is still more common. The vitellin grains of the marbled torpedo (Torpedo marmorata,) from La Rochelle, are very different in shape from those of the Ray, the former being elliptical or circular: there are no rectangular grains; their transparency and their other physical properties are the same. They are only two hundredths of a millimeter, but it is not to be forgotten that the Torpedos are never large. Ichthin of sharks is in larger grains, more elongated than those of the Ray, and of a very long oval shape. We have noticed, too, some variations in the form. In a careful microscopic ex-

amination, we saw one of these ovoid grains pointed at both ends. Another had the two long straight sides, terminating in two isoceles triangles; it was the figure of an elongated hexagon. The hound-fish (Squalus mustelus, *Lin.*), smaller than the "Melandre," has grains of ichthin almost as large as those of the latter. They are five hundredths of a millimetre; their form is different from all the others. These grains are round, but often united in the most varied forms. The Bounce (la ronsette, Squalus canicula, *Lin.*) has rectangular grains and obtuse angles, very like those of the Ray; their longer side is four hundredths of a millimeter. The angel-fish (l'ange, Squatina angelus, *Dum.*) has as large grains as the Squalus mustelus; they are elliptical like those of the shark, and as large, for they are six hundredths of a millimeter. We conclude then, from the comparison of the forms of these grains in the different species cited, that the oviparous species like the Ray and Bounce, have more or less rectangular grains, and are very much alike, while the Cartilaginous viviparous species, like Torpedos and Sharks, generally have oval grains; that if the development of the ovula influences the largeness of the grains of ichthin, the size of the fish has no effect on the size of the grains.

The grains of ichthin are insoluble in water, alcohol and ether; they are completely transparent, and do not become opaque by being kept even for a long time, in boiling water; hydrochloric acid dissolves them without producing a violet color: the two latter properties clearly establish the difference between ichthin, albumen and vitellin. All the concentrated acids dissolve ichthin; when they are dilate, they do not act upon it, excepting acetic and phosphoric acids, which immediately dissolve grains of ichthin, even when greatly diluted with water. Solutions of potash and soda are slow solvents of ichthin. It is insoluble in ammonia. Grains of ichthin when burnt, leave no ashes. When the ease with which ichthin can be obtained from the eggs of certain fish is considered, and when it is seen that grains of ichthin, by the regularity of their form, offer all the characteristics of a really pure principle, it is impossible not to consider it as one of the most interesting substances in the animal organization. Ichthin, when analyzed, gives the following composition:

	I.	II.	III.	IV.	V.	VI.
Amount of material,	0·452	0·427	0·282	0·228	0·332	0·406
Water, - - -	0·275	0·300	0·195	0·150		
Carbonic acid, - -	0·845	0·800	0·520	0·420		
Azote,					0·049	0·062

The results give the percentages:

Carbon, - - - - -	50·9	51·0	50·2	50·2
Hydrogen, - - - -	6·7	7·8	7·6	7·3
Azote, - - - - -	14·7	15·4		

Its centesimal composition will then be:

C 51·0 H 6·7 Az 15·0 Ph 1·9 O 25·4

It is easy to believe, that these regularly formed tables are small crystals. To remove doubts in this respect, we have had recourse to the kindness of M. de Sénarmont, who examined our grains with a polarizing apparatus. This proved to him and to us, that the grains of ichthin are not crystallized.

ART. VIII.—*The Arabic or Indian Method of Notation;* by THOMAS H. MCLEOD.

THE subject of arithmetical notation in its relation particularly to the Arabic or Indian, the Roman, and Grecian systems, has arrested the attention of mathematicians from the earliest period of modern mathematical investigation; but the mechanical structure, especially of the Indian, seems to have been overlooked, as well as the probable circumstances under which that structure originated.

Barlow, in his Theory of Numbers, presents the following equation,

$$N = ar^n + br^{n-1} + cr^{n-2} + \&c. \ldots . pr^2 + qr + w,$$

where r may be any number whatever, and a, b, c, &c. integers less than r, as expressing the scheme of the Indian method. It is undoubtedly a formula by which that method may be explained; but that it exhibits its simple primitive mechanical structure, may be justly questioned. For in the first place it does not show the first position of 0 (zero) with any reliable certainty: the only place we are left to refer it, from the explanations, is to 10, where it appears on the right of 1, which we apprehend is not its first place; secondly, r appears in the form of a power, which is unquestionably true, but accidental; thirdly, it is asserted that r may be any number whatever, yet upon examination it will be found always to assume the form 10, whatever be its significance in the denary measure; and finally, it cannot be in any manner supposed that the scheme had its origin in philosophy, as the formula would seem to indicate, but that it arose out of the circumstances and necessities of the people from whom it sprung.

Having finished these few restrictions, of which more might be made, concerning what mathematicians have said upon this subject, we shall proceed to explain what we consider to be the simple primitive structure of the Indian method, and afterwards allude by way of comparison to that of the Grecian and Roman methods.

The first peculiarity of the Indian method is its 0 (zero), which stands as the *origin* of the scheme, as will be seen by writing it out thus:

0, 1, 2, 3, 4, 5, 6, 7, 8, 9,

where it evidently appears in its first place. The next characteristic worthy of note, is the 10, which does not appear among the

above figures; it is evidently made up of 1, and 0, but how from this circumstance does it get its significance? We conceive the way to be this: It is well known to land-surveyors and other lineal measurers, that the place where the measuring commences is but a point and has no lineal significance, and that the first unit of measure is at the distance of a unit from that point, and the second at two measures, and the third three, &c.; i. e. in measuring land the first pin is stuck at the distance of one chain, or measure, from the place of beginning, the second at the distance of two chains, the third at the distance of three chains, and so on. If then the place of beginning be represented by 0, and the several distances respectively by 1, 2, 3, 4, &c., the whole will be properly expressed. But when the pins are all exhausted and a *tally* is to be made, how is it to be done? Very naturally by placing down a 1, and a 0 (zero) (which has no lineal significance) to the right; the fact is thus recorded, and will read, one tally and no more; at the distance of one small measure (or one chain) from this point, a 1 tally and 1 chain will be marked down (11) and the expression will read one tally, and one chain more; and so on to the second tally, which will be made and recorded by a 2 and a 0, to the right (20), which will read two tallys and no more. At the distance of one small measure or unit from this place there will be recorded 2 tallys and 1 chain more, or 21, which will read two tallys and one chain; at the distance of two small measures, the record will be 22, which will read two tallys and two chains, and so on.

This we conceive to be the simple structure and probable origin of the Indian method. In its structure it is strictly *geometrical*, using that term in its primitive signification.

It will at once be perceived that the tally is not necessarily made at one small measure beyond 9, but that it may be made at any measure before or beyond that place; but in each case the point of repetition will always be expressed by 10, and this from the fact that it necessarily reads one principal or large measure and no more. This verifies the statement before made that r, in Barlow's formula, will always be expressed by 10, and that its appearing as a power is accidental. The whole subject will be clearly exhibited by the following Table:

0	1	2	3	4	5	6	7	8	9	θ	ϕ
10	11	12	13	14	15	16	17	18	19	1θ	1ϕ
20	21	22	23	24	25	26	27	28	29	2θ	2ϕ
30	31	32	33	34	35	36	37	38	39	3θ	3ϕ
40	41	42	43	44	45	46	47	48	49	4θ	4ϕ
50	51	52	53	54	55	56	57	58	59	5θ	5ϕ
60	61	62	63	64	65	66	67	68	69	6θ	6ϕ
70	71	72	73	74	75	76	77	78	79	7θ	7ϕ
80	81	82	83	84	85	86	87	88	89	8θ	8ϕ
90	91	92	93	94	95	96	97	98	99	9θ	9ϕ
$\theta 0$	$\theta 1$	$\theta 2$	$\theta 3$	$\theta 4$	$\theta 5$	$\theta 6$	$\theta 7$	$\theta 8$	$\theta 9$	$\theta\theta$	$\theta\phi$
$\phi 0$	$\phi 1$	$\phi 2$	$\phi 3$	$\phi 4$	$\phi 5$	$\phi 6$	$\phi 7$	$\phi 8$	$\phi 9$	$\phi\theta$	$\phi\phi$

It will here be seen that the repetitions do not necessarily begin at one measure beyond 9 but may begin at any measure before or after that point. It will also be seen how 10 obtains its significance.

The Grecian Method, was also a method of large and small measures, but it had no 0 (zero), 1 (a unit) being the first figure in the scheme, whence, it evidently had its origin in the consideration of individual objects and not in the measure of distances, i. e. it is *arithmetical*, using that term also in its primitive sense. It employs the letters of the Greek alphabet for its characters, the first letter representing a unit, the second letter two units, &c., to ten, which is expressed by ι (iota), the tenth letter of the alphabet; with this character the repetitions begin. A new character is introduced at each repetition, as at twenty, thirty, and so on to one hundred, to represent which a new character is added, when the whole is repeated; new characters are added for each hundred afterwards, to one thousand, which is also represented by a new character, as well as ten thousand, and one hundred thousand, &c. The scheme seems then to be simply this: one, ten and one,—twenty, twenty and one,—one hundred, one hundred and one,—one thousand, one thousand and one, &c. It is seen, contrary to what has been stated, that any number could be expressed by this method, all that was necessary being to introduce a new character at the end of the proper repetition. If the Greeks did not express any number beyond 100,000,000, it was because they either did not understand the scheme of their notation, or because at this point it became unwieldy; the latter was probably the case. It will be also seen that the repetition can commence and be carried on with any number whatever.

The Roman Method, is rather a method of fives than of tens. It begins its repetitions with five, introducing a new character to express that number. It introduces new characters to express ten, fifty, one hundred, five hundred, one thousand, in each case making use of the previous figures in connection with the new ones to express the numbers beyond them. Thus:

I,	II,	III,	IIII,	V,
VI,	VII,	VIII,	VIIII,	X,
XI,	XII,	XIII,	XIIII,	XV,
XVI,	XVII,	XVIII,	XVIIII,	XX,
XXV,	XXX,	XXXX,	L, C,	D, M,

which evidently reads, five, five and one, ten, or two fives—for so do some at least explain the figures—two fives and one, three fives, three fives and one, four fives, four fives and one, &c., fifty, fifty and one, one hundred, one hundred and one, five hundred, five hundred and one, one thousand, one thousand and one, &c. It is also evident that it had its origin in contemplating and recording individual objects like the Grecian method, as like it, it

is destitute of 0, and consequently its *origin** is a number and not a point.

In comparing these three methods, especially the last two with the first, it is manifest that they had an essentially different source. It is equally certain that the Indian method could not have originated with the Chaldeans, who numbered their flocks and herds and counted the stars, in which operation the unit would hold the first place in their notation; from which circumstance it is not improbable that the Grecian or Roman method came from them, or perhaps from the Phenicians, from whom came also their alphabets. But it is certain that we must look to some different part of the globe to find the makers of the Indian method, to some Egyptian people, to some land measurers, like the dwellers on the Nile,—who indeed may have been the very ones. In an ethnological point of view, if in no other, these circumstances may be of importance, for numbers, like some word of a language, may hold in their secret embrace some untold history of man.

As a result of employing different measures, as circumstances require, in numerical expressions, it will be found that any vulgar fraction can be made to assume the integral, or decimal form, a circumstance which is often overlooked. Take for instance the problem of finding the one-third of ten, or the dividing ten by three. The well-known result is 3·33333333 &c., without a complete expression being attained; but the difficulty will be obviated by using a measure of three, when ten will assume the form 101 and the three, 10.† When the operation is performed with these expressions, thus, $101 \div 10$, the result will be as seen, 10·1, which is a complete expression: but it should be observed that this is not read ten and one-tenth, but three and one-third, just as the same expression in the denary measure is read ten and one-tenth, the advantage gained being that it is a complete expression, by this method. Should all the measures of the Indian method be developed up to twelve, there would be ten additional ways in which the same number of units could be expressed, by which definite results could be obtained. Leibnitz claimed and received the credit of *inventing* the binary measure which would not have been, had he or his cotemporaries fully

* Employing the word in the sense in which it is used in Conic Sections.

† When 3 assumes the form 10, 9 will assume the form 100, and consequently 10, being 1 more than 9, will assume the form 101. Not that it should be considered to contain one hundred and one units, but that in the ternary measure it is the expression for 10. Barlow's Rule for reducing numbers in the denary measure to any other measure is as follows:

Divide the given number and several quotients as expressed in the denary measure, by the proposed measure, and note the remainders; these remainders, read in an inverse order, will express the given number in the proposed measure. Thus change 1810 in the denary measure to the ternary measure: dividing 1810 by 3 gives 603 and 1 remainder; so 603 by 3 gives 201 and 0 remainder; 201 by 3, 67 and 0 remainder; and so on. The several remainders afford for the result 2111001, for the ternary measure.

understood the Indian method, according to which it was developed. Hutton observes that he had seen a book printed in Germany in which rules for operating with each measure to twelve was given, but does not intimate that he or the author regarded it as a development of the several measures of one scheme, but seems to consider it, as mathematicians in general appear to do, as so many independent methods. Could the several schemes, and especially the Indian, be properly developed in all their different measures, the subject of numbers would assume a more general aspect.

Middlebury, Vt., September, 1845.

ART. IX.—*On the Effect of the Pressure of the Atmosphere on the Mean Level of the Ocean;* by Captain Sir JAMES CLARK Ross, R.N., F.R.S.*

THE author states that, in September, 1848, Her Majesty's ship Enterprise and Investigator having anchored in the harbor of Port Leopold in lat. 74° N. and lon. 91° W., a heavy pack of ice was driven down upon and completely closed the harbor's mouth, thus effectually preventing their egress, and compelling them there to pass the winter of 1848–49. It was during that period that the series of observations here presented to the Royal Society was obtained; and, as the observations were made under peculiarly favorable circumstances, the author considers they will throw some light on the movements of the tides, and on some of the causes of their apparent irregularities.

Soon after the harbor had been completely frozen over, a very heavy pressure from the main pack forced the newly-formed sheet of ice, which covered the bay, far up towards its head, carrying the ships with it into such shallow water that at low spring-tides their keels sometimes rested on the ground. Under these circumstances the movements of the tides became to the author an object of great anxiety, and consequently of careful observation, in order to ascertain the amount of irregularities to which they were liable in that particular locality.

The first few days' observations evinced much larger differences in the elevation or depression of successive high or low-waters than could be accounted for by any of the generally received causes of disturbance; and the author was at once led to connect them with changes of the pressure of the atmosphere, from perceiving that on the days of great atmospheric pressure high-water was not so high as it ought to have been, and low-water was lower than its proper height; and that the reverse took place on the days of smaller pressure.

* Proc. Roy. Soc. Lond., June, 1854; Lond., Edin. and Dub. Phil. Mag., Oct. 1854, p. 318.

As it was found that the usual method of determining the mean level of the sea, by taking the mean of successive high- and low-waters, was inadequate to the detection of small quantities arising from a change in the pressure, a system of observation was adopted different from that heretofore practised, in order to determine the mean level of the sea on each day.

In the first instance, simultaneous observations of the height of the tide and of the mercury in the barometer were made every quarter of an hour throughout the twenty-four hours. From these it was found that the mean level of the sea for each day could be determined with great accuracy, and that the variation in the daily mean level and in the mean pressure of the atmosphere followed each other in a remarkable manner, so that a rise in the former corresponded to a diminution in the latter. Subsequently, however, hourly observations were adopted.

The peculiar advantages of the position of the ships at Port Leopold for making tidal observations are stated to have consisted in :—

1. The great width of the entrance of the harbor admitting the free ingress and egress of the water, combined with the large field of ice which covered the whole of the bay, completely subduing every undulation of the water.

2. The steady movement of the immense platform of ice, rising and falling with such singular regularity and precision as to admit the reading off the marks of the tide-pole with the greatest exactness, even to the tenth of an inch.

3. The shallowness of the water and the evenness and solidity of the clay bottom admitting the fixture of the tide-pole with immovable firmness.

4. The whole surface of the sea in the neighborhood being, for the greater part of the time, covered by a sheet of ice, preventing those irregularities which occur in other localities from the violence of the wind raising or depressing the sea in as many different degrees as it varied in strength or duration.

For fixing the tide-pole for the "Enterprise" a hole 2 feet square was cut through the icy platform, and a strong pole, nearly 40 feet long, was passed through it and driven firmly down several feet into the clay, being fixed by heavy iron weights, which also rested on the clay and prevented any movement of the pole. It was placed in about 21 feet depth of water at the time of mean level of the sea. Another such tide-pole was, in like manner, fixed through a hole in the ice close to the "Investigator," for the sake of reference and comparison.

Hourly observations of the height of the tide and of the barometer were commenced on the 1st of November, and were continued by the officers of each ship throughout the whole of the nine following months to the end of July. After forty-seven days

of observation an interruption in one of the series occurred in consequence of the tide-pole of the "Enterprise" having been drawn up the ice, to the under part of which it had become frozen. The amount of displacement of the pole was easily determined by a comparison with that of the "Investigator," but several days elapsed before it could be satisfactorily fixed at the same point in which it had been originally. The observations of these forty-seven days are those which are given in the paper, and their discussion is the immediate object of the communication.

It is stated that subsequent observations seem to show that, from the time of the interruption to the middle of July, there was a progressive elevation of the mean level of the sea, which although of small amount, was sufficiently evident from month to month to render the subdivision of the series desirable, in order that the individual observations of each separate division should be strictly comparable.

The height of the sea and the corresponding height of the mercury in the barometer, at every hour in each day, from the 1st November to the 18th December 1848 are given in tables. In these the arithmetic mean of the hourly heights of the sea for each day is taken as the mean level of the sea for that day, and the mean of the hourly heights of the barometer is taken as the corresponding height of the barometer. These mean levels and corresponding mean barometric heights are given in another two-column table, arranged in the order of the days of observation; and in a third table these are arranged in the order of the heights of the barometer with the corresponding mean levels, without regard to the dates of observation, for the purpose of showing the dependence which the latter have on the former.

On these tables the author makes the following remarks. The forty-seven days of hourly observations give for the mean height of the baromerer 29·874 inches, and of the mark of the mean level of the sea 21 feet 0·21 in.

The mean of three days of *greatest* pressure was	30·227, and of corresponding level	20 feet 8·4 inch.
The mean of three days of *least* pressure was	29·559, and of corresponding level	21 feet 5·4 inch.
	Diff. +0·668	Diff. −9·0

Thus a difference of pressure equal to 0·668 inch produced a difference of 9 inches in the mean level of the sea. As the ratio of 9 to ·668 is 13·467 to 1, the author considers that the effect of the pressure of the atmosphere on the level of the sea is 13·467 times as great as the effect it produces on the mercury in the barometer, or very nearly in the inverse ratio of the specific gravities of sea-water and mercury. He however states that this remarkable coincidence must be considered in a great measure accidental, for if a greater number of days' observation be taken in order

to deduce the mean greatest and mean least pressure, and the corresponding mean levels, a different result will be obtained. From these observations however he considers that he has been enabled to deduce results which plainly point to the law which governs the effect of the pressure of the atmosphere on the mean level of the sea, and may be encouraged to pursue the investigation through a more extended series of observations, in order to arrive at the most accurate conclusion that the observed facts may justify.

In conclusion a formula is given for determining the correct height of the tide, or of the mean level of the sea:—

Let L denote the correct height of the tide, or of the mean level of the sea;
B the mean pressure of the atmosphere;
λ the observed height of the tide, or of the mean level of the sea;
β the corresponding height of the barometer;
D the ratio of the specific gravity of mercury to that of sea-water:

then $L=\lambda+(\beta-B)D$.

Examples are given of the application of this formula.

ART. X.—*Report to the Academy of Sciences, Paris, on the Researches relative to Earthquakes of M. Alexis Perrey;* by the Commission, MM. LIOUVILLE, LAMÉ, and ELIE DE BEAUMONT reporter.*

THE Academy has charged us, MM. Liouville, Lamé and myself, with reporting on a memoir presented March 21, 1853, by M. Alexis Perrey, Professor in the Faculty of Sciences of Dijon, *On the relations which may exist between the frequency of Earthquakes and the age of the moon*, and on a Note presented the 2d of January, *On the frequency of Earthquakes relatively to the times of the moon's passing the meridian.*

When the memoir of M. Perrey was presented on the 21st of March, M. Arago was appointed on this commission. The death of our illustrious confrère, which happened soon after, left a vacancy in the Commission; and subsequently to the reading of the Note on the 2d of January, one of our number, M. Lamé, was named for the place.

Arago, whom nothing escaped which bore on the physics of the globe, followed with continued interest the researches of M. Alexis Perrey. The Academy has not forgotten the care with

* From the Comptes Rendus, xxxviii, June 2, 1854.

which he called attention to the Notes on Earthquakes addressed to him of late years by the learned Professor of Dijon, and he has often mentioned at our meetings the relations indicated between the frequency of earthquakes and the age of the moon.

The cause of the interest connected with these relations is easily understood. If, as is now generally supposed, the interior of the earth is in a liquid or pasty state through heat, and if the globe has for its solid part only a crust comparatively very thin, the interior liquid mass must tend to yield like the surface waters to the attractive forces exerted by the sun and moon, and there must be a tendency to expansion in the direction of the radius vectors of these two bodies; but this tendency encounters resistance in the rigidity of the crust, which is the occasion of fractures and shocks. The intensity of this cause varies, like that for the tides of the ocean, with the relative position of the sun and moon, and consequently with the age of the moon: and it should also be noted, that as the ocean's tides rise and fall twice in a lunar day, at periods dependent on the moon's passing the meridian, so in the internal fluid of the globe, there should be two changes in a day, the time varying with the same cause.

Without entering now into more details, it will be easily conceived, that if the mobility of the internal mass of the globe plays a part in the production of earthquakes, there must be some dependance, admitting of study, between the occurrence of an earthquake, and the circumstances which influence the action of the moon on the whole globe or on any place or portion of it, that is, the angular distance with the sun, its actual distance from the earth, and its distance from the meridian of the place, or in other terms, the age of the moon, the time of perihelion, and the hour of the lunar day.

These considerations which have not escaped M. Alexis Perrey, have beyond doubt inspired the idea of the two-fold work which we have been charged to examine; and they have obtained for the views, the interested attention of M. Arago and many other men of science. They have involved on the part of the author the determination of the precise date, and period of the moon, for each earthquake on record and even for each shock of which earthquakes may consist—a work of vast labor; the researches have been now continued for several years and are still in progress. * *

In the memoir of the 21st of March, 1853, on the relations between the frequency of earthquakes and the age of the moon, the author devotes the first chapter to the tabulation and the numerical transformation of the results of observation.

He has conceived four modes of tabulating the facts.

In the first method, followed in his memoir presented to the Academy on the 5th of May, 1847, the author reckons as a day of earthquake each of those on which the earth has been shaken, whether

it has happened only in one country or on the same identical or different hours in two or several countries, separated by intervals not participating in the movement. Noting then, after the Connaissance des Temps, to what day of the lunation, each day of earthquake corresponded, he brings together in one column all the days which pertain to the first day of a lunation; in a second, all pertaining to the second day of a lunation, and so on. Thus he forms a table consisting of 30 columns, each column giving the number of days of earthquake corresponding to the successive days of the moon. The numbers vary, and the law of variation is the same in his first table comprising a register of 2735 days of earthquakes between 1801 and 1845, as in his later one embracing 5388 days between 1801 and 1850. In both tables, the number of earthquakes during days near the syzygies is a little larger than in days near the quadratures.

In his second method, the author regards as distinct, the earthquakes in different regions separated by an undisturbed region, and each day of earthquake is counted 1, 2, 3, &c., according as the earthquakes of this day were experienced in 1, 2, 3, &c. separate regions. By this new mode of tabulating, the number 2735 is increased to 3041, and that of 5388 to 6596. The same law is observed in these new tables as in the first set: and similar also is the result obtained by dividing the half century into two quarter centuries.

In the third method of arrangement, M. Perrey takes as a distinct phenomenon each of the shocks of which a single earthquake is composed, and registers it separately. But he has not the documents for completing this work, as the number of shocks often is not stated. The author has contented himself by considering by this method 931 shocks felt in Central America and mostly at Arequipa, as published by M. de Castelnau in the 5th volume of his "Voyage dans les parties Centrales de l'Amerique du Sud." This table, without giving identical results with the preceding, leads to the fundamental relation already mentioned.

Finally, in the fourth method of arrangement, the application of which is difficult and has not yet been made by M. Perrey, the collection of shocks in a country, preceded and followed by a period of tranquillity is regarded as a single phenomenon.

To the nine tables formed by one or the other of the first three methods of tabulating, the author has added a tenth, formed by the first mode: it embraces four years, from 1841 to 1845, and only 422 days of earthquakes. Although this number is small the numbers lead to the same general conclusion—that is, the greater frequency of earthquakes at the syzygies than at the quadratures.

This general law, although distinctly observable in the series of results, is however obscured by many anomalies. In order to eliminate these anomalies as far as possible, Prof. Perrey divides the 29·531 days of a lunar month into twelfths, sixteenths and eighths, and obtains, by proportional calculations applied to the number of the different tables constructed according to the solar days, the numbers which correspond to each fraction of lunation. In his new tables thus constructed, excepting some minor anomalies, the law above stated is more fully confirmed, that for a half century earthquakes have been more frequent at the syzygies than at the quadratures.

M. Alexis Perrey has also enquired whether a relation exists between the frequency of earthquakes and the distances, at the time, of the moon from the earth. For this purpose he has tabulated according to the different methods of tabulation pointed out, the number of times the earth has been shaken, on the day of the perigee and apogee of the moon, the day before, night before, the following day, and the next following; he has hence ascertained, by the groups of numbers thus formed, the total corresponding to the perigee, and also to the apogee. In order to facilitate a comparison of the results, he has taken the difference of the totals thus obtained and divided by their sum, whence he has found the quotients

$$\frac{1}{16\cdot5},\ \frac{1}{23\cdot6},\ \frac{1}{23\cdot5},\ \frac{1}{24\cdot4},\ \frac{1}{29\cdot2},\ \frac{1}{18\cdot6},\ \frac{1}{21\cdot2},\ \frac{1}{10\cdot75},$$

which are all, above $\frac{1}{30}$, and the last nearly equals $\frac{1}{10}$. It appears therefore that the unequal attractions of the moon on the earth at its greatest and least distance from the earth, has a sensible influence on the production of earthquakes.

In the Note of Jan. 2, *On the frequency of earthquakes as related to the passage of the moon over the meridian*, the author aims to discover whether the repetition of the shocks of earthquakes during a lunar day, has, like the tides, a relation to the moon's passing the meridian. He has submitted to this investigation, 824 shocks observed at Arequipa, registered by M. Castelnau, after calculating the hour of each, with reference to the moon. He has thus made out a table, which he afterwards divided into 16 equal parts, and then grouped these by twos into 8 parts, using the mean lunar day of 24 hours 50½ minutes. In this way, notwithstanding some large anomalies which cannot fail to be presented in so small a number of cases, the number obtained by each mode of grouping, gave evidence of the existence in the course of the lunar day, of two epochs of maximum number of shocks and two of minimum, the former at the times of the moon's passing the meridian—the superior and inferior—and the latter at intermediate intervals.

M. Alexis Perrey, by discussing the catalogues which he had formed, thus shows by three ways independent of one another, the influence of the course of the moon on the production of earthquakes.

1. That the frequency augments in the syzygies.

2. That the frequency augments in the vicinity of the moon's perigee, and diminishes towards the apogee.

3. That the shocks of earthquakes are more numerous when the moon is near the meridian than when 90 degrees from it.

The tables still present more anomalies, and the author has omitted nothing which should remove them, so as to bring out the law in all its purity.

He at first thought of representing the frequency by diagrams like those for barometrical observation, a process by which the general march of phenomena is perceived amid the anomalies which tend to mask it. We regret that this has not been done, as it speaks at once to the eye. M. Alexis Perrey has endeavored to obtain his results by calculation, and has devoted to this subject the second chapter of his principal memoir, and the second part of his Note of Jan. 2, 1854.

Without attempting to follow the author in these analytical discussions, we simply state here that, in order to represent the results of observation, he employs a formula of interpolation of the form,

$$\varphi = m + A \sin(t+\alpha) + B \sin(2t+\beta) + C \sin(3t+\gamma) + \ldots$$

in which m, A, B, C, &c., are constant coefficients of the same nature with φ; α, β, γ, &c., are constant angles; and t a variable angle dependent on the lunar motion, which is equal to 0 degree for the new moon, 90 degrees for the first quarter, and 180 degrees for full moon, &c. He then adapts the formula by known methods to each of his tables deduced from observation, by determining the constants which it includes.

By means of the formulas thus obtained, the author has been able to form tables corresponding to those made simply from observations in which the law of the phenomena is presented, free from the principal anomalies which tend to conceal it in the first tables. The numbers contained in these new tables have been constructed with care and have led to regular curves in which the law is expressed fully and clearly. All the curves have a marked resemblance, although not wholly similar:—an identity could not be, for the results are only approximative and take a special impress from the groups of numbers which they represent. The resemblance in the curves leads to two principal maxima, corresponding to the syzygies, and two minima for the quadratures; and sustains the general deduction, that for half a century earthquakes have been most frequent at the syzygies.

The Academy will perceive the importance of this conclusion, and may judge at the same time from the preceding, of the care with which the author has pursued the subject, he having brought together for the half century 7000 observations. This number is however still small for the solution of a problem of this kind, and it is important to increase it both by adding the facts of successive years, and also by going back to past centuries, which the author has already commenced.* * * *

ART. XI.—*On the Periodical Rise and Fall of the Lakes;* by MAJOR LACHLAN, Montreal.†

FEW countries can boast of objects of more imposing natural grandeur or deeper philosophical interest, than are presented in Canada, in the vast extent and other striking peculiarities of its magnificent inland *fresh water* seas, and their noble connec tng rivers and unrivalled cataracts, coupled with the singularly anomalous nature of its climate and seasons compared with European countries in the same parallel of latitude: and an additional geographical interest may be considered as attaching to it, in the magnetic meridian passing through it—the line of "No variation" curving through part of its mediterranean waters.‡

The investigation of the causes and effects of these great physical phenomena might well engage the attention of a whole life of patient observation and study; and such, doubtless, will at no distant day, be the case; but in the present state of things, in so young a country, all that can be expected is the occasional contribution of the unpretending philosophical *gleaner;* and, as such, I now venture to lay before the Canadian Institute the following desultory observations on the periodical rise and fall of our great Lakes, in the hope of strengthening the arguments adduced by me in the paper which I had lately the honor of submitting to it, in advocacy of the establishment of a system of simultaneous meteorological and tidal observations throughout British America—as not only a great philosophical desideratum, but also likely to prove of substantial service to the country, were it only to make us better acquainted with the great benefits de-

* This Report closes with a recommendation to the Academy that an appropriation should be made to enable M. Alexis Perrey to complete his valuable researches —especially for books, travelling, and transportation of documents, &c., and in accordance with it a considerable sum was placed at his disposal.

† Read before the Canadian Institute, March 18th, 1854; Canadian Journal, July, 1854.

‡ To do justice to the subject treated of in this paper, a good map of British America should be at hand to be refered to, and, above all others, that graphic "Map of the Valley of the St. Lawrence," constructed by T. C. Keefer, Esq., in which the striking connection of the whole system of Lakes is so well portrayed.

rived and derivable from the climatic influence of our mighty inland waters.*

In the introduction to my former paper, I was led to remark that it is now seventeen years since my attention was first attracted to these interesting philosophical subjects, by remarking the great difference in the newspaper reports of the temperature, direction of the winds, and state of the weather in different parts of the Province at the same time, as compared with each other, and by having been in the habit for seven years, at my residence on the banks of Lake Erie, of noticing the constant extraordinary fluctuations in the level of that noble Lake; at times consisting only of slight irregularly recurring oscillations; at others, showing a sudden change of level, apparently caused by the temporary impulse of passing storms; at others, evincing a longer continued state of elevation or depression, in evident accordance with the more enduring influence of winds blowing from the same quarter for days together; and at others, and more especially and unaccountably, of a longer maintained rise of several feet above the usual level, sometimes lasting for a whole season, or even more, as was the case during the memorable years, 1838–39—regarded at the time by some of my neighbors as the traditional seven years' flood.

Being much struck with these singular phenomena, and yet not being sufficiently at leisure, besides feeling myself otherwise disqualified for attempting a scientific investigation of their causes, I naturally felt, nevertheless, a strong desire to ascertain what had been written on the subject, or might be, from time to time, by more able philosophical observers; and I accordingly made a practice of taking notes from all such published works, and other sources of information, as referred to them, as they happened to fall in my way, until I had, in the course of years, accumulated a mass of miscellaneous memoranda—not to call it testimony—on the subject, of so conflicting a character as frequently rather to add to the perplexity than promote the elucidation of the object in view; and the consequence was, that, after vainly attempting to classify and reconcile the information therein contained, regarding the rise and fall of the Lakes generally, and comparing it with my own passing observations and enquiries respecting Lake Erie in particular, I came to the con-

* As a remarkable instance of the *tempering* influence of the proximity of the Lakes, it may here be mentioned, that in the immediate vicinity of Cleveland, the temperature during ten years has in no instance fallen below zero, while at Columbus, Marietta, and Cincinnati, from 120 to 150 miles farther south, it has frequently sunk to 5 deg. and 10 deg. below it; and that in Northern Ohio, generally, the tender vegetation is usually cut down within five days of the 25th of October, whereas the Lake shore remains untouched for two weeks later; and during the winter, when deep snow falls elsewhere, there is comparatively little near the Lake. —American Journal of Science, 2nd Series, vol. xiii, pp. 215 to 219.

clusion that there was still much room for further investigation, as all the Lakes did not appear to be always governed by simultaneous influences;* and therefore, that the only chance of arriving at a correct knowledge of the state of the whole matter, would be the adoption of some such course of long continued meteorological and tidal observations throughout the country, as that which I ventured to propose in my last paper.

Having in that communication enlarged principally on the value of a wide-spread series of simultaneous meteorological observations, as the more important branch of the great object in contemplation, I propose to confine myself, on the present occasion, to the no less interesting, though minor, part of the undertaking—aiming at the institution of a simultaneous record of the daily variations in the level of the great Lakes, with the view of throwing light on, and, if possible, deciding, the three following doubtful points: 1st, How far there is any foundation for the traditional report, that there is a septennial rise and fall in the waters of the Lakes, and if so, to what height; and whether such phenomenon takes place in all the Lakes simultaneously or otherwise. 2d, The amount of the better known annual variations in the level of the different Lakes; and how far these changes occur in each at the same time; and whether they are solely due to the annual amount of the rain and snow in the surrounding country, compared with that of the evaporation during the summer months, or to any other cause therewith combined. And 3d, How far the daily or other more frequent oscillations, or irregular tides, observable in the different Lakes, are general, and arise from the temporary force and direction of winds passing over their surface, or are peculiar only to certain localities; and whether they are in any sensible degree influenced by atmospheric pressure, or lunar attraction, or otherwise. All which, it is hoped, would in the course of time be satisfactorily decided, by a daily record of the actual level of the Lakes, combined with that of the prevailing winds and weather, at a fixed number of stations, at hours simultaneous with the other meteorological observations.

Taking it, at all events, for granted that such will be the case, I proceed, as an indispensable preliminary step, to take a discursive view of a yet debateable state of the question, as brought home to my mind by a comparison of the casual observations made by myself on Lake Erie, compared with the recorded opinions expressed by others, possessing either greater ability, or more leisure and better opportunities, for prosecuting such an enquiry,—as far as the very miscellaneous and disjointed memoranda accumulated by me will enable me to do so.

* This will be found patiently illustrated in a tabular view of the Rise and Fall of Lake Erie, incorporated in this paper.

In accordance with this intention I may, in the first place, remark, that though the phenomena connected with the various periodical fluctuations in the level of the lakes appear to have attracted the notice of philosophic travellers near two centuries ago, they remained altogether uninvestigated till very lately. The minor tides or oscillations were first alluded to by Fra Marquette, the Jesuit, in 1673, and more particularly by the Baron La Hontan in 1689: and they were afterwards further noticed by Charlevois in 1721, and also by the British travellers, Mr. Carver in 1766, and Mr. Weld in 1796; but it was not till twenty years afterwards that the whole subject began to engage the particular attention of men of science in America, and especially of the talented individuals engaged in the Geological Surveys of the States of New York, Ohio, and Michigan: in this period, I find them successively noticed by Col. Whiting in 1819 and 1829, Mr. Schoolcraft in 1820, General Dearborn in 1826, and Governor Cass in 1828; and more particularly by Professors Hall and Mather, Colonel Whittlesey, Dr. Houghton, Mr. Higgins, and others, in their valuable official reports, from 1838 to 1842; as well as by various observant British officers and travellers, such as Captains Bayfield and Bonnycastle, and Messrs. McTaggart, Macgreggor, and others, the purport of all of whose observations will be found more or less glanced at in the sequel:—and yet, strange to say, these singular phenomena still remain involved in mystery!

It so happens that the observations of all the early writers on this interesting subject were confined to Lakes Superior, Michigan and Erie, and were directed more to the daily fluctuations or tides remarked at particular places, than to the actual existence of the traditionary great septennial rise and fall of the waters of the whole Lakes. Thus, for instance, Baron La Hontan, on reaching Green Bay, at the northern extremity of Lake Michigan, at its conjunction with Lake Huron, remarks that where the Fox river is discharged into that Bay, he observed the waters of the Lake swell three feet high in the course of twenty-four hours, and decrease as much in the same length of time. And he also noticed a contrariety and conflict of currents in the narrow strait which connects Lake Huron and Michigan, which were so strong that they sometimes sucked in the fishing nets, although two or three leagues off. In some seasons it also happens that the current runs three days eastward, two days westward, and one day to the south, and four days to the northward, sometimes more and sometimes less.

Charlevois also noticed similar appearances; and supposes Lakes Huron and Michigan to be alternately discharged into each other through the Straits of Michilimackinac; and mentions the fact that in passing that Strait his canoe was carried by the current against a head wind.

But it was not till fifty years afterwards that we were indebted to that intelligent British traveller, Mr. Carver, for any great additional light on this mysterious subject, as well as for other particulars regarding the then unknown region of Lake Superior, from information acquired on the spot. But as his remarks are alluded to by a subsequent equally respectable and observant English writer, Mr. Weld, who visited Canada in 1796, we are content to refer to the interesting volume of the latter for the following (much condensed) appropriate observations.*

"It is confidently asserted, not only by the Indians, but also by great numbers of the white people who live on the shores of Lake Ontario, that the waters of this Lake rise and fall alternately every seventh year. Others, on the contrary, deny that such a fluctuation does take place; and, indeed it differs so materially from any that have been observed in large bodies of water in other parts of the globe, that I am tempted to believe it is merely an imaginary change. Nevertheless when it is considered, that, according to the belief of the oldest inhabitants of the country, such a periodical ebbing and flowing takes place, and that it has never been clearly proved to the contrary, we are bound to suspend our opinions on the subject. For instance; a gentleman who resides close upon the borders of the Lake, not far from Kingston, and had leisure to attend to such subjects, told me that he had observed the state of the Lake for nearly fourteen years, and that he was of opinion that the waters did not ebb and flow periodically; yet he acknowledged the very remarkable fact that several of the oldest white inhabitants in his neighborhood declared, previous to the late rising of the Lake, that the year 1795 would be the high year; and that in the summer of that year the Lake actually did rise to a very uncommon height. He said, however, that he had reason to think

* I take the opportunity of here remarking that I might easily have imparted a seeming greater degree of originality to this paper by continuing to make only occasional reference to parts of information derived from different writers, and connecting them with a few second-hand observations in my own language; but feeling myself already dissatisfied on that head, and being desirous of exhibiting the whole evidence on the question, independent of any opinion of my own, I have adopted a more equitable course, in allowing as much as possible, my authorities to speak for themselves, in their own language. I may at the same time add, that, in perusing the following and other hurriedly copied extracts and memoranda, accumulated at uncertain intervals during a course of more than fifteen years, and frequently at times when opportunities of access to books were "like angels' visits, few and far between," it must be borne in mind that they were made without any view to publication, and simply for the purpose of furnishing the means of hereafter comparing the observations of different writers on an important philosophical question in which I had long taken a deep interest; and that they will, therefore, perhaps often be found neither altogether verbatim nor regularly connected, and perhaps even betraying not a few verbal errors; but whatever their defects may be, compared with the originals, the reader may be assured that there was no intention to alter or distort the meaning or merits of the author, and that they may therefore be considered as a faithful epitome of more extended observations.

that the rise on this occasion was wholly owing to fortuitous circumstances, and not to any regular established law of nature; and that its being greater than usual was more imaginary than real; and he formed this opinion from the circumstance that when the Lake had risen to its unusual height in 1795, he had questioned some of the oldest people as to the comparative height of the water on this and former occasions, when they affirmed that they had seen it equally high before." Now, a grove of trees which immediately adjoined this gentleman's garden, of at least thirty years' growth, was entirely destroyed this year by the waters that flowed amongst them; and if, therefore, the Lake had ever risen so high before, this grove would have been then destroyed; a circumstance militating strongly against the evidence as to the height of the waters, but which only proved that they had risen on this occasion higher than they had done for thirty years' preceding, and *not* that they had not during that term risen *periodically* above their usual level.*

What Mr. Carver relates concerning this subject rather tends to confirm the opinion that the waters of the Lake do rise periodically. "I had like to have omitted (he says) a very extraordinary circumstance relative to these Straits (of Michilimackinac, between Lakes Michigan and Huron). According to observations made by the French, whilst they were in possession of the fort there, although there is no diurnal flood or ebb to be perceived in these waters, yet from an exact attention to their state a periodical alteration has been discovered. It was observed that they arose by gradual but almost imperceptible degrees till they had reached the height of three feet. This was accomplished in seven and a half years; and in the same space of time they as gently decreased, till they had reached their former situation. So that in fifteen years they had completed their inexplicable revolution. At the time I was there, the truth of these observations could not be confirmed by the English, as they had then been only a few years in possession of the fort, but they all agreed that some alteration in the limits of the Straits was apparent." "It is to be lamented (added Mr. Weld judiciously) that succeeding years have not thrown more light on this subject. . . . A long series of observations are neccessary to determine positively whether the waters of the Lakes do or do not rise and fall periodically. It is well known, for instance, that in wet seasons they rise much above the ordinary level, and that in very dry seasons they sink considerably below it; a close attention, therefore, ought to be paid to the quantity of rain that falls, and to evaporation; and it ought to be ascertained in what degree the height of the Lake is

* The destruction of these trees would depend more on the length of time they were inundated, than on the mere fact of their having been temporarily flooded. —R. L.

altered thereby, otherwise, if it happens to be higher or lower than usual on the seventh year, it would be impossible to say with accuracy whether it were owing to the state of the weather, or to certain laws of nature, that we are as yet unacquainted with. At the same time great attention ought to be paid to the state of the winds, as well in respect to their direction as to their velocity —for the height of the water in all the Lakes is materially affected thereby. Moreover, these observations ought not to be made at one place only, but at different places at the same time. . . .

"It is also believed by many persons that the waters of Lake Ontario not only rise and fall periodically every seventh year, but that they are likewise influenced by a tide which ebbs and flows frequently in the course of twenty-four hours—as, for instance, in the Bay of Quinté, where it has been observed to rise fourteen inches every four hours. But there can be no doubt that this must be caused by the wind—no such regular fluctuation being observed at Kingston, and this Bay being a long crooked inlet, that grows narrower at the upper end; and therefore not only a change of wind up and down would make a difference at the upper extremity, but the waters, being concentrated there, would be seen to rise or fall, if impelled even in the same direction, whether up or down, more or less forcibly at one part of the day than another. . . An appearence like a tide must therefore be seen almost constantly at the head of this Bay, whenever there is a breeze. I could not learn that the fluctuation had ever been observed during a perfect calm; were the waters, however, influenced by a regular tide, during a calm, that would be most readily seen."

Reserving any comments on the foregoing pertinent extracts for a future page, I proceed to remark, that such continued to be the unsatisfactory amount of information on this interesting debatable philosophical question, till about 1819, when Capt. (afterwards Col.) Whiting, of the American army, at length recurring to the exciting subject, made, at the request of Governor Cass, a series of regular observations upon these oceanic appearances, during seven or eight days, in the month of June, serving to show that at that remarkable inlet, Green Bay, there is a daily rise and fall, but that it is irregular as to the precise period or flux and reflux, and also as to the height which it attains;* and yet such was the variety of opinion among local residents on the fact, that he is compelled to state, in the course of his remarks, that being led to suppose that the winter would be the most favorable time for making such observations, when the superincumbent ice would nearly destroy the influence of the winds, and show the unassisted operation of the tide, he made enquiries as to its appearance during that season, when one gentleman informed him

* See American Journal of Science, vol xvi, pp. 90 and 91.

that *no* tide was then discernible, while another, equally intelligent, assured him that it was *very apparent*, and that there was a regular elevation and depression of the ice!

From all which conflicting circumstances (as correctly observed by, I think, Mr. Schoolcraft in the same article) there was reason to conclude that a well-conducted series of experiments would prove that there are *no* regular tides in the Lakes; at least, that they do not ebb and flow twice in twenty-four hours, like those of the ocean; that the oscillating motion of the waters is therefore not attributable to planetary attraction; and that it is very variable as to the periods of its flux and reflux, depending upon the levels of the several Lakes, their length, depth, direction, and conformation, upon the prevalent winds and temperature, and upon other extraneous causes, which are in some measure variable in their nature, and unsteady in their operation.

Colonel Whiting further remarks in another interesting article on the supposed tides and periodical rise and fall of the North American Lakes,* in which is given a table of observations kept at Green Bay, in six weeks, July and August, 1828, that an examination of that record would satisfy any one that planetary influence had little or nothing to do with the changes of elevation in the waters there noted; and that it was as certain that the fluctuations in some places appear to be independent of atmospheric as of lunar control; as, by consulting that table, there would probably not be found one instance where the time of high water tallies with the moon's southing, admitting the usual retardation. And further, that it would also be seen that the changes of elevation were independent of the course of the wind; for that the fluctuation continues, notwithstanding the winds remaining the same. He, therefore, came to the conclusion that, reasoning from our knowledge of the great inland waters of the other hemisphere, we should take it for granted that the North American Lakes have no sensible tides; the Caspian, Black, and Baltic Seas being said to have none worthy of observation, and even the Mediterranean being indebted to the sharp-sightedness of modern times for the knowledge of there being such a phenomenon on her wide spread bosom.† Col. Whiting, however, subsequently remarks, writing in 1830, with regard to what General Dearborn terms "the periodical increase of the whole volume of waters in the American Lakes," that it is the popular tradition on these Lakes that there has been a rise and fall once in every fourteen years, or that its recurrence has been sufficiently precise to authorise the belief in its regularity; but that the New York Canal Commissioners state the intervals to be once in about eleven years; and that no actual observations appeared to have been

* See American Journal of Science, vol, xx, pp. 205 to 219.

† See close of this article.—R. L.

made on the progress of the elevation, as to whether there were any preceding seasons of a character to produce it; and, therefore, after noticing various well-known periods at which remarkable elevations and depressions took place, such as in 1800, 1815, 1820, 1828, and 1830, by way of proof of the periodical return of that phenomenon being regular or otherwise, he was obliged to come to the conclusion that, as far as *facts* go they are certainly in favor of the popular theory, but that it rests on these facts alone, and is in many other points of view improbable and absurd; and that we are therefore constrained to suppose, though destitute of the light of actual observation, that the fluctuations observed must have been caused by unusually abundant rains and snow, and that this abundance had been in fortuitous coincidence with certain *cycles* of time; for, improbable as this may be, it is less so than that nature should have departed from her ordinary course.*

Having, in a previous page, quoted largely from Mr. Weld, I now proceed to notice the judicious remarks on the rise and fall of the Lakes by another intelligent British observer, Mr. McTaggart, who, writing in 1828, sets out by at once *affirming* that "there are no tides in any of the Lakes—none, at least, from the moon's influence; but that the floods of spring generally raise them from three to four feet. It is stated that Lake Ontario rises once in every seven years higher than usual by two feet. The people ascribe this to some supernatural cause. In the spring of 1827 it had one of these periodical tides rising nearly three feet higher than it had done in the previous year, and keeping high the whole summer. Being in the neighborhood (observes Mr. McT.) I paid the utmost attention to the phenomenon, and found that there fell during that summer much more rain than had fallen for many years before; and that there was little sunshine throughout the season; and I, consequently, concluded that the exhalations from the Lake were not so copious. There was another circumstance that puzzled me. Lake Ontario, and indeed, all the Lakes were up to their very highest surface marks, *but the rivers flowing out of them were not.* Those surface marks were very obvious on the rocky shores of the Lakes, drawn like so many chalk lines by Nature herself.

"Rivers do not rise exactly from the same cause as Lakes. If in spring the snow melts off the country on a sudden, and the frozen swamps break up and disembogue their contents, then the rivers will rise to their utmost height as water pours into them on all sides; but when the sun has effected this, they begin to fall. Lakes swell, it is true, from the same cause, but not with the same comparative haste; their surface being of great extent, the floods can only spread over them by slow degrees; and if the sky keep

* See American Journal of Science, vol. xx, pp. 218, 219.

cloudy and the weather moist, so that little evaporation goes on, the surface of the Lake will continue to swell, while that of the river will fall—as the country on either side is drained—nothing tending to keep up its flood but the mere discharge from the Lake. Rivers and Lakes are never at their utmost pitch of flood at the same time; neither are they ever at the lowest ebb at the same time; for when the floods of a river have subsided to a certain extent, the intense heat of the summer sun, setting upon the shelving sides of the rocky channels, and even upon the bed of the river itself, tends greatly to promote the absorption of the waters, whereas in the deep wide Lake this action cannot take place.

"The unusual rise of the waters of the Lakes in some seasons, which some observers state to be seven feet above the common level, seems to be only rationally accounted for by the absence of evaporation, and greater quantities of rain than generally prevail. Once in every seven years it is said to rise thus; but 7, like 3, is a number open to superstition,* not to be always relied on, and it would not be surprising if this flow were to happen once in six, or even in ten years. It will yet, likely, be discovered that when Lake Erie has its brim flood, the others have theirs also during the same season; and when powerful suns are excluded from drinking them up, by the intervention of drizzling clouds, and this exclusion extending over an immense surface, we shall cease to marvel at these wonderful septennial floods. It has also been remarked that the winters after these seasons have had little snow; but *meteorology on this score remains to be further prosecuted, ere the theory dare be advanced, that it is from the moisture absorbed in circumjacent regions* during summer that the snows of winter are supplied."

Passing from the borders of Lake Ontario to the regions of Lake Superior, I am next enabled to refer to some equally peremptory observations on the same subject, made by that eminent British hydrographer and geologist, Capt. Bayfield, on the spot, in the course of 1825–26; from whose valuable and interesting paper on the geology of the latter Lake I extract the following particulars:†

"There is no regularly periodical rising or falling of the Lakes, as has been asserted, whether it be from the influence of the moon, or any other. They rise and fall from accidental causes; such as a very severe winter without the usual thaws. The springs are locked up all winter, and the whole accumulated snow remains until the spring, when the weather, becoming suddenly

* It was stated by Professor Johnston, in his address at the New York Agricultural Society meeting at Syracuse, as a fact, that Holland is exposed on the average of the last thirteen centuries, to one great sea or river flood, every seven years —R. L.

† See Transactions of the Lit. and Hist. of Quebec, vol. i, pp. 1 to 43.

warm, dissolves it at once. Hence it will generally be found that after a very severe winter, the waters of the Lakes will be much higher than at other times. Heavy gales also raise the water in the upper parts of the Lakes, and also cause *currents* in various directions. The rise, however, in Lakes Superior and Huron, from this or any other cause, never exceeds a few feet. . . . Whether a gradual diminution of the waters of Lake superior is now going on, is a point on which no one is qualified to give an opinion; for no observations have been made or recorded to ascertain the interesting fact. Any diminution must be always imperceptibly gradual, and would require constant, accurate, and regularly recorded observations during a great number of years to render this indisputable. The streams which discharge into Lake Superior amount to several hundreds in number, and the quantity of water supplied by them is many times greater than that discharged at the falls of St. Mary, the only outlet. There is, however, no reason to imagine from this that the quantity of water increases; for it is absolutely necessary that there should be a supply very far exceeding the discharge, to replace the immense expenditure arising from the evaporation from so extensive a surface."

Adhering to my intention of reserving for the present any comments on the above, as of other quotations, I now revert to the next American writer on this important subject, namely, General Dearborn, who, in the 16th volume of the American Journal of Science, already referred to, observes that "it is not sufficiently certain that tides may not be produced in the great chain of Lakes, in the same manner as they are in the ocean;" and in proof thereof quotes an elaborate theory of the distinguished Dr. Young (illustrated by three diagrams) which had at that time been sanctioned by the scientific for more than twenty years, not only presuming the possible existence of such tides, but furnishing the means of demonstrating that such is the fact in deep and broad Lakes, and even going so far as, where the area and depth of a lake is known, to give a theorem by which the maximum rise and fall of the waters and the time of its oscillation, or in which a tide wave might pass over it, can be ascertained.* But the General at the same time admits, with regard to "the periodical increase and diminution of the whole volume of water in the Lakes," that he is in possession of no definite facts, save what was contained in a letter from Captain Dearborn, stating, that whilst stationed at the Sault Ste. Marie, on Lake Superior, he had himself observed for three successive days an ebb and flow of one-and-a-half feet, in the course of about two-and-a-half hours each; but that he attributed it to the winds; and that he sup-

* See American Journal of Science, vol. xvi, pp. 78 to 94, and Young's Natural Philosophy, vol. i, p. 578, &c. See also beyond, in this article.

posed that the rise and fall which takes place during periods of from three to seven years, to be possibly the effect of increased depth of water in the Lake, caused by an unusual amount of snow on its borders and tributary streams, or an uncommon rainy season; and that it even appeared from an extract from the *New York Advertiser*, that a gentleman just then (1828) returned from a tour to the West, had informed the editor that the waters of Lakes Ontario and Erie were then nearly a foot higher, while those of Lake Superior were considerably lower than ever known. The General was therefore led to suggest that, to obtain full, and exact data as to the rise and fall of the different Lakes tide-guages should be placed at a number of points on the shore of each, both in their narrowest and broadest dimensions, and the changes carefully observed for a whole year, or at least for several months, and accurate tables kept of the times and extent of each flux and reflux, in which the position, as respects the meridian and the phases of the moon, and also the course of the winds should be noted;—a plan which, it will be perceived, is very similar to that proposed by myself in my late paper on the establishment of simultaneous meteorological observations.

(*To be continued.*)

ART. XII.—*Synopsis of the Ichthyological Fauna of the Pacific slope of North America, chiefly from the collections made by the U. S. Expl. Exped. under the command of Capt. C. Wilkes, with recent Additions and Comparisons with Eastern types;* by L. AGASSIZ.

CYPRINOIDS.

IN order rightly to appreciate the natural relations of the representatives of this family living in the fresh waters of the western slope of this continent, to those found in the waters of its eastern slope and elsewhere, it is important first to reconsider the many genera established by Rafinesque in his "Ichthyologia Ohiensis," as well as those recently added by Messrs. Baird and Girard, and to institute a careful comparison between them and those founded by European ichthyologists; for though it is gratifying to behold the zeal with which important additions are daily making to our fauna by the activity of the scientific members of the various expeditions which have lately explored the western parts of the United States by order of the Central Government, it is deeply to be regretted that no more criticism is displayed in the notices which have been published descriptive of these animals. Instead of careful comparisons with more or less allied foreign forms, we are presented with such descriptions of our fishes and reptiles, as would leave the impression that nothing like them is to be found in any other part of the world.

The family of Cyprinoids presents peculiar difficulties whenever we attempt to characterise its genera, as is too well shown by the conflicting views of those who have written upon this subject.

This difficulty arises chiefly from the uniformity of its representatives, greater than is observed, in most other families, and also from the necessity of resorting to dissections to trace their most important characteristics.

In a paper published in 1834 in the Mémoires de la Société des Sciences Naturelles de Neuchâtel, I have however shown that reliable characters may be obtained from the pharyngeal teeth, and the more recent investigations of Heckel upon this subject have confirmed my statements and extended them over a large number of genera and species unknown to science at the time I published the results of my first investigations. At the time Heckel published his valuable remarks upon Cyprinoids, he seems to have been but scantily provided with American representatives of this family.

It is this gap in our knowledge I intend to fill here in connection with a more full description of the species collected in Oregon and California by the naturalists of the expedition of Capt. Wilkes.

The propriety of establishing new genera among Cyprinidæ will appear very questionable to the ichthyologists who have traced the almost endless divisions to which this family has of late been submitted. Nevertheless I feel compelled to introduce some new divisions among them, to classify several fishes which have been collected by the United States Exploring Expedition, and some others long known from the eastern parts of this continent.

Few Cyprinidæ have as yet been described from the fresh waters of the northwest coast of America, and the species brought home by the Exploring Expedition form an interesting addition to our knowledge.

The first question which arises upon examining these fishes is naturally,—to what genus do they belong? Are they in any way analogous to the Cyprinidæ of the eastern or Atlantic side of North America, or do they resemble those of western Europe, or are they in any way related to the Asiatic types? As soon as I knew that species of that family had been preserved among the collections of the Exploring Expedition, my first care was to examine their generic relations, and, to my utter astonishment I found that they do not belong to any of the numerous genera established by myself, Heckel, Prince Canino, or McLelland for the species of the old world, and that, with one exception, they correspond as little to any of the types which occur in the eastern parts of the North American continent. They constitute in fact by themselves a natural group of species, remarkable for the development of their lips, and the horny covering which protects

the outline of the mouth. Their pharyngeal teeth also, as far as I have been able to ascertain, have a peculiar structure. Even if the subdivision of the Cyprinidæ into genera had never been extended beyond the limits marked out by Cuvier, three, at least of the species from Oregon should be admitted as new types of this family, for which genera I shall propose the names of Mylocheilus, Ptychocheilus and Acrocheilus.

TRIBE OF CATOSTOMI.

Heckel subdivides the family of Cyprinoids into ten tribes, the fourth of which embraces our Catostomi. This tribe is very natural, if we exclude from it the genus Exoglossum, the true affinities of which are with Chondrostoma and not with Catostomi as Heckel admits. The true Catostomi have very remarkable pharyngeal bones, with a large number of compressed teeth, arranged like the teeth of a comb, upon the inner prominent edge of these bones, and gradually increasing in size from above downwards, whilst in Exoglossum the teeth are few in number, obliquely truncate and occupying only the middle of the curve of the pharyngeals as in Chondrostoma.

For a long time past I have sought in vain to find out the homology of these curious pharyngeal teeth, so peculiar, and so characteristic in the family of the Cyprinoids. It was not until I began to investigate the various types of the old genus Catostomus, that I found a clue to their true significance. The armature upon the inner curve of the branchial arches of Cyprinoids differs so completely from the common type of their pharyngeal teeth, in the genera of the old world, that even a comparison between them is hardly suggested; but in Catostomus the extensive row of comb-like teeth, upon the posterior edge of the inner margin of the pharyngeal arches is so combined with a row of horny serratures upon the anterior edge of the same margin, that the homology of the two becomes at once obvious. See fig. 2, a' and a''. The pharyngeal teeth correspond to the armature upon the inner curve of the branchial arches; they may, however, be either simple epidermic serratures or papillæ, or assume the structure of genuine teeth and become soldered to the bone upon which they are formed, as is the case also with the maxillary teeth of so many fishes.

Notwithstanding the similarity of the general arrangement of the pharyngeal teeth in all Catostomi, there are still such differences in their form and number, and especially in the shape of their inner edge, that these peculiarities afford additional evidence of the propriety of acknowledging several genera among them, most of which have already been indicated, though very indiffer-

ently characterised by Rafinesque. In order to ascertain beyond a question the generic value of these characters I have examined the pharyngeals of every one of the species described in this paper, and of several of them compared a number of specimens of different ages and sexes with one another, and I have invariably found that within the limits within which the genera are circumscribed here, they present a peculiar type for each genus, reproduced in the different species with slight variations in the size and proportions of the teeth, the strength of the arch and the length of its symphysis.

Thus far the whole tribe of Catostomi must be considered as belonging exclusively to North America, the true relations of the Catostomus Tilesii, founded by Valenciennes, upon the description of the Cyprinus rostratus, from Northern Asia, by Tilesius being still doubtful, or wanting at least the only confirmation acceptable in our days, that is based upon a direct comparison of original specimens. Catostomi are found as far south as Texas and along the northern boundaries of Mexico, as is shown by the descriptions of several species published by Messrs. Baird and Girard in the Proceedings of the Academy of Natural Sciences of Philadelphia for 1854, but I have been unable to ascertain whether they inhabit the waters of Cuba.

It is a very interesting fact that while America has no native representation of the tribe of Carps, some of its Catostomi, the Carpiodes, Ichthyobus and Bubalichthys, remind us strongly by their external appearance of the true Cyprini of the old world, whilst others, the Cycleptus and Moxostoma resemble more the Borbus of Europe, Asia and Africa and the Tinca of Europe, which are also entirely wanting in America, and still others, the Catostomi proper have not even analogous representatives in the eastern continents.

Carpiodes, Raf.

1. The body is very high and strongly compressed, the narrow ridge of the back forming the outline in front of the dorsal is very much arched, and regularly continuous downwards with the rather steep profile of the head.

The head is short, its height and length differ but little. The snout is short and blunt. The small mouth is entirely inferior, and surrounded by narrow thin lips, which are more or less transversely folded. The lower jaw is short and broad.

The pharyngeal bones of Carpiodes are remarkably thin, compressed laterally, with a shallow furrow along the anterior margin on the inside, and another more central one on the outline of the arched surfaces; the teeth are very small, compressed, equally thin along the whole inner edge of the bone, forming a fine comb-like crest of minute serratures; their cutting edge rises above the

inner margin into a prominent point. Fig. 1, *a*, represents the inner surface of the right pharyngeal, *b*, the dental edge of the two pharyngeals in their natural position, *c* and *d*, magnified teeth in profile.

1.

The anterior lobe of the long dorsal is slender, its third and fourth rays being prolonged beyond the following ones into long filaments. The lower fins are all pointed, rather small, and hence distant from one another. The ventral ridge of the body is flat. The scales have many narrow, radiating furrows upon the anterior field, and one, more deeply marked, in a straight line, across the lateral fields, or limiting the lateral and posterior fields, hardly any upon the anterior field, the waving of the broader concentric ridges producing only a radiated appearance upon that field. Tube of the lateral line straight and simple, arising in advance of the centre of radiation, which is seated in the centre of form of the scales.

Cuvier referred erroneously the type of this genus to his genus Labeo, in which he has been followed by DeKay, whilst Valenciennes founded upon it his genus Sclerognathus. Rafinesque however, had already called it Carpiodes; this latter name having the priority, must therefore be retained. Moreover Valenciennes describes as a second species of that genus under the name of Sclerognathus Cyprinella, a fish from Lake Pontchartrain, which belongs to Rafinesque's genus *Ichthyobus*, as I shall show below. In recognising the generic differences which distinguish these two fishes, Rafinesque has really been much in advance of more recent observers, though the characteristics he ascribes to them are very loosely and imperfectly drawn.

I know now four species, of this curious genus, one of which inhabits the fresh waters of our middle States, emptying into the Atlantic, the Catostomus Cyprinus of Lesueur; another occurs in Lake Champlain and the waters of our Northern States, emptying into the St. Lawrence, the Catostomus Cyprinus of the Rev. Zad. Thompson; a third is found in the Ohio, and its tributaries, and has been described under the same name as the preceding ones, by Dr. Kirtland in his "Fishes of the Ohio." I have lately obtained a fourth from the Osage River, through the kindness of Mr. George Stolley, which I have inscribed as *Carpiodes Bison* in my notice of the Fishes of the Tennessee River.* It occurs also in the Mississippi, above its junction with the Missouri, as I have ascertained recently from specimens forwarded to me by Dr. Rauch of Burlington, Iowa; whether it is found farther south, I do not know.

* See this Journal, 2nd Ser., vol. xvii, p. 356.

In my enumeration of the fishes of the southern bend of the Tennessee River, I made a mistake in preserving the name of *C. Cyprinus* for the Ohio species; but having known that species for many years, I took it as the type of the genus the more readily, since Rafinesque has established the genus Carpiodes from Ohio specimens. Yet this species, *C. Cyprinus*, was described by Lesueur from Pennsylvania specimens, so that the name of *C. Cyprinus* belongs to it by right of priority, and the name of *C. Vacca* which I have applied in my notice of the fishes of the Tennessee River to the Pennsylvania species, must be considered as a mere synonym of *Catostomus Cyprinus* of Lesueur, and the Ohio species must retain Rafinesque's name of *Carpiodes velifer*. Lesueur himself had already pointed out in the Journal of the Academy of Natural Sciences, vol. i, p. 110, the differences he noticed between some specimens obtained in the Ohio River, by Mr. Thomas Say, and preserved in the Museum of the Academy of Nat. Sci. in Philadelphia, and those from the Chesapeake Bay he described under the name of *C. Cyprinus*. Upon these indications, Rafinesque founded his *Carpiodes velifer*, Ich. Oh., p. 56, without perceiving that it is identical with his own *Carp. Carpio;* though he had already a few lines higher in the page called it *C. setosus*, referring that name erroneously to Lesueur. Again page 51, Rafinesque describes the same species once more, from a drawing of Mr. Audubon, under the name of *Catostomus anisopterus*, referring it to his subgenus Moxostoma, though he points out himself its true affinity to *C. velifer*. With these materials before me, I was very anxious to obtain also original specimens of the fish described by Rev. Z. Thompson, under the name of C. cyprinus, from Lake Champlain. To that gentleman himself, I am now indebted for the means of comparing it with the species described by Lesueur and Rafinesque, and I find that it is still another species for which I propose the name of *C. Thompsoni*.

These species, though very similar in general outline and compression of body, instantly strike one on comparing them as distinct; the different form and size of scales give to each a very peculiar appearance. In *Carpiodes velifer*, which has the largest scales, their hind border is very broadly arched or rounded, whilst in *Carpiodes Thompsoni*, it forms a very blunt or open angle. Hence in the former species, the posterior margin of a row of scales extending obliquely from the dorsal to the ventral region is strongly waved, but in the latter species it is straight. In Carpiodes velifer the radiating lines on the opercle are more prominent, and the subopercle is longer and not so broadly rounded at its lower angle, and the anterior lobe of the dorsal is higher and much more slender than in Carpiodes Thompsoni. *C. Cyprinus* is more elongated than either, and *C. Bison*, from Osage River, is

the most elongated of the four species, and its snout is most prominent. Valenciennes states that *C. Cyprinus* occurs also in Lake Pontchartrain, Louisiana; but this is incorrect. He has mistaken my *C. Taurus*, which belongs to the genus Bubalichthys, for the true Cyprinus of Lesueur. This result shows how important it is in identifying fishes from distinct water basins, not to trust implicitly to descriptions for comparison, but to resort as far as possible to original specimens. I shall have full opportunity below to show also how dangerous it may be to take for granted that because fishes occur in distant regions, they must differ specifically, and to describe them as such.

Whether *Carpiodes tumidus*, B. and G., from Texas, belongs to this or the following genus, or to Ichthyobus, I am unable to ascertain from the description published by Messrs. Baird and Girard in the Proceedings of the Academy of Natural Sciences in Philadelphia, 1854, p. 28.

I am entirely at a loss to understand why Rafinesque should have referred his *Catostomus xanthopus* with C. Cyprinus and Velifer to his subgenus Carpiodes. It certainly does not belong to the same genus as the description shows, in which the dorsal is said to be "hardly falcate with 14 rays," I have scarcely any doubt that Rafinesque had an old specimen of Lesueur's *Catostomus nigricans* before him when he described his *Cat. xanthopus*. Not supposing that species to occur in the Ohio, he did not even compare it with the description of Lesueur; but the name "mud sucker," the specific name xanthopus and the statement that the "head is larger, flattened above," &c., apply together only to Cat. nigricans, which, as Dr. Kirtland has already shown, and as I also know from direct observation, is not only found in the Ohio, but occurs very extensively in our western waters, even as far as Osage River, whence I have obtained specimens through Mr. George Stolley, and also in the middle Atlantic States.

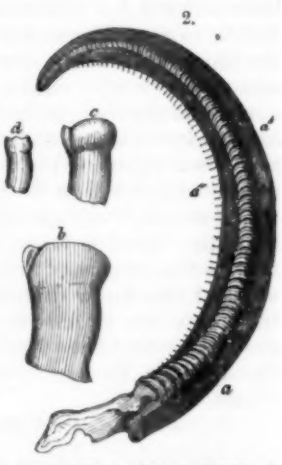
Bubalichthys, Agass.

At the time I vindicated the propriety of restoring some of the genera established by Rafinesque among Cyprinoids.* I did not suspect that the genus Carpiodes as I then represented it, still contained two distinct types, though I had noticed that some of the species had the anterior margin of their dorsal greatly prolonged, whilst in others it hardly rises above the middle and posterior portion of that fin. Having since examined the pharyngeals of all the species of this tribe which I have been able to secure from different parts of the country, I find that those with a high dorsal, which constitute the genus Carpiodes proper, have in addition very thin flat pharyngeals with extremely minute teeth, whilst those with a low dorsal have triangular pharyngeals with

* See this Journal 2nd Ser., vol. xvii, page 353.

larger teeth, increasing gradually in size and thickness from the upper margin of these bones towards their symphysis. The difference in form of these bones arises from the circumstance that the slight ridge upon the outer surface of the arch in Carpiodes is transformed in this second type into a prominent edge, dividing the outer surface of the arch into a posterior and an anterior plane, meeting under an acute angle. This structural homology is satisfactorily traced by the difference in the external appearance of these two planes, the posterior one being full as the posterior half of the flat outer surface of the arch in Carpiodes, whilst the anterior plane is coarsely porous, indeed studded with deep pits analogous to the porous character of the anterior half of the outer surface of that bone in Carpiodes. The teeth themselves are compressed; their grinding edge is rather blunt, slightly arched in the middle, and provided with a little cusp along the inner margin which is hardly detached from the crown and does not rise above its surface, as in Carpiodes, Ichthyobus and Cycleptus.

Fig. 2, *a*, represents the right pharyngeal seen from behind, *a'* being the crest of teeth, *a''* the armature of the anterior edge of the inner curve, *b* one of the lower, *c* one of the middle, and *d* one of the upper teeth.



In this genus the bulk of the body is not placed so far forwards as in Carpiodes, the greatest height being midway between the head and tail. The upper outline of the body is less strongly arched in advance of the dorsal; the head is longer than high, and the snout not more prominent than the mouth. The mouth opens obliquely downwards and forwards, the lower jaw being nearly as long as the upper. The lips are small and granulated. The anterior rays of the dorsal are not separately prolonged beyond the rest of the fin, though its anterior margin is higher than its middle and posterior portion. The lower fins are as in Carpiodes.

The scales have many narrow radiating furrows upon the anterior field, none across the lateral fields, and few upon the posterior field, converging to the centre of radiation to which the tubes of the lateral line extends also. For this new genus I propose the name of Bubalichthys, intending to recall the name of Buffalo fish, commonly applied to its species. To this genus belong the species I have described as *Carpiodus Urus* from the Tennessee River,* *C. Taurus* from Mobile River, and *C. Vitulus*

* See this Journal, 2nd Ser., vol. xvii, p. 355 and 356.

from the Wabash, and also the *Catostomus niger* of Rafinesque and *Catostomus Bubalus* of Dr. Kirtland from the Ohio, but not *Cat. Bubalus*, Rafinesque, which is the type of the genus Ichthyobus described in the following paragraph. I have another new species from the Osage River, sent me by Mr. George Stolley. This shows this type to be widely distributed in our western waters; but thus far it has not been found in the Atlantic States. I have some doubts respecting the nomenclature of these species which are rather difficult to solve. It will be seen upon reference to Rafinesque's Ichthyologia Ohiensis, p. 55 and 56, that he mentions two species of his subgenus Ichthyobus, one of which he calls *C. Bubalus*, and the other *C. niger;* the second he has not seen himself, but describes it on the authority of Mr. Audubon as "entirely similar to the common Buffalo fish, his *C. Bubalus*, but larger, weighing sometimes upwards of fifty pounds." Dr. Kirtland, on the other hand, describes the *C. Bubalus* as the largest species found in the western waters, and adds that the young is nearly elliptical in its outline and is often sold in the market as a distinct species, under the name of *Buffalo Perch*. If there was only one species of Buffalo in those waters the case would be very simple, and the Catostomus Bubalus and niger of Rafinesque, and C. Bubalus of Dr. Kirtland, should simply be considered as synonymous,* but Dr. Rauch of Burlington has sent me fine specimens of this Buffalo Perch, to which the remark of Dr. Kirtland, "elliptical in its outline," perfectly applies, and I find that it not only differs specifically but even generically from the broader, high-backed, common Buffalo, and being the smaller species, I take it to be Rafinesque's C. Bubalus, the type of his genus Ichthyobus, which is more fully characterised below, whilst the larger species, Rafinesque's C. niger, can be no other than Dr. Kirtland's C. Bubalus, "the largest species of the western waters." It seems therefore hardly avoidable to retain the name of C. niger or rather *Bubalichthys niger* for the common Buffalo, though Rafinesque, who first named that fish, never saw it, or if he saw it mistook it for his own Bubalus, and though Dr. Kirtland, who correctly describes and figures it, names it C. Bubalus, for such is the natural result to which the history of the successive steps in our investigation of these fishes lead. But our difficulties here are not yet at an end. Among the splendid collections I have received from Dr. Rauch, I found two perfectly distinct species of *Bubalichthys*, one with a large mouth, and the other with a small mouth, and one of *Ichthyobus*, living together in the Mississippi River, in the neighborhood of Burlington, Iowa, and the next question, probably never to be

* Dr. Kirtland and Dr. Storer, who follows him, are certainly mistaken in referring C. niger of Raf., to Cat. elongatus of Lesueur, as the description in the Ichthyologia Ohiensis clearly shows.

solved, will be, if they all three occur also in the Ohio, whether Rafinesque's C. niger was the big-mouthed or the small-mouthed Bubalichthys. Judging from the figure, given by Dr. Kirtland in the Boston Journal of Natural History, vol. v, pl. 19, fig. 2, I believe his C. Bubalus to be the small-mouthed species. I myself have however only seen one specimen of the big-mouthed species from the Ohio, and that in a rather indifferent state of preservation, for which I am indebted to Prof. Baird, and none of the small-mouthed species. Should however all three, as is possible, occur as well in the Ohio, as in the Mississippi, to avoid introducing new names, I would call the big-mouthed species B. niger, preserving for it Rafinesque's specific name,—the small-mouthed, B. Bubalus, retaining for it the name which Dr. Kirtland has given it, even though the species of Ichthyobus must bear the same specific name, being that originally applied to it by Rafinesque. It may be that either my B. Vitulus or my B. Urus is identical with Dr. Kirtland's C. Bubalus, but until I can obtain original specimens of his species, this point must remain undecided, as it is impossible from mere descriptions to institute a sufficiently minute comparison. The specimen from Osage River, I shall call B. Bonasus.

Compared with one another, these species differ as follows: *B. niger* (the big-mouthed Buffalo) differs from *B. Bubalus*, (the small-mouthed Buffalo) by its larger mouth, opening more forwards, its more elongated body, the first rays of the dorsal rising immediately above the base of the ventrals, and its anterior lobe being broader, and the anal fin not emarginated; *B. Bonasus* differs from B. Bubalus and from B. niger in having the mouth larger than the first and smaller than the second, and from B. Bubalus by its less emarginated dorsal, which renders its larger lobe broader, anal fin not emarginated, opercle larger. A farther comparison with the southern species could only be satisfactory if accompanied by accurate figures.

I therefore turn now to the genus—

Ichthyobus, Rafin.*

In the form and position of the fins, as well as in the general outline of the body, this genus is very nearly related to Bubalichthys, but in the structure of the parts of the head, it is quite dissimilar. The mouth opens directly forwards, and is large and round. The lips are small, smooth and thin; the upper one is not thicker than the intermaxillary itself and tapers to a narrow edge. At the symphysis of the lower jaw, which is larger than in any other genus of this group, the lower lip is hardly more than a thin membrane connecting its small lateral lobes.

* Rafinesque spells the name incorrectly Ictiobus; as its name means Bull or Buffalo fish, from ἰχθὺς and βοῦς it ought to be spelled Ichthyobus, as I have already stated it in my Nomenclature Zoologicus: Index universalis, p. 194.

The eye is small, and the opercular pieces very large.

The scales have many narrow radiating furrows upon the anterior field; none across the lateral fields, few upon the margin of the posterior field and these not extending to the centre of radiation. Tubes of the lateral line straight and simple, arising nearly in the middle of the posterior field.

The pharyngeal bones are neither flat, as in the Carpiodes, nor triangular as in Bubalichthys, but present an intermediate form; the outer surface of the arch standing outwards, and presenting a porous outer margin. The peduncle of the symphysis is much longer proportionally and more pointed than in Carpiodes and Bubalichthys. The teeth are very numerous, small, thin and compressed as in Carpiodes, but the lower ones are gradually larger than the upper ones. Their inner edge is slanting outwards, and not uniformly arched as in Bubalichthys, or truncate as in Cycleptus, the innermost margin rising somewhat in the shape of a projecting cusp.

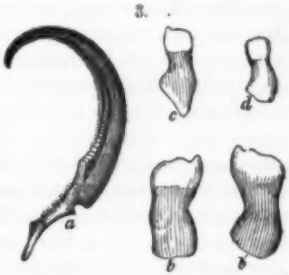


Fig. 3, *a*, represents the right pharyngeal of *Ichthyobus Rauchii*, from the inner side, *b* and *b'* lower teeth from both sides, *c* a tooth from the middle of the comb, and *d*, one from its upper end.

Thus far a single species of this genus has been accurately described by Valenciennes, under the name of *Sclerognathus Cyprinella*, from lake Pontchartrain, near New Orleans; but as I have remarked above, the genus Sclerognathus can not stand, since it includes two distinct types, for both of which Rafinesque has already introduced unobjectionable names. One of these genera is founded upon the Catostomus Cyprinus of Lesueur, and will retain the name of *Carpiodes*, as characterised above, the other is the subject of this paragraph, for which the name of *Ichthyobus* must be preserved, even though its typical species C. Bubalus was so imperfectly described by Rafinesque as to be mistaken by Dr. Kirtland for the common Buffalo of the Ohio, as I have shown above. *Ichthyobus Bubalus*, Raf., is easily distinguished from the two following new species by its low dorsal, its small fins, and high scales.

Ichthyobus Rauchii.—Dorsal much higher than in I. Bubalus, all other fins much larger, and the scales not higher than long; from Burlington, Iowa. Received from Dr. Rauch, to whom I am indebted for a very large collection of fishes from the Mississippi, and its tributaries in the State of Iowa.

Ichthyobus Stolleyi.—Body higher than in Ichthyobus Rauchii, profile steeper, and hence snout blunter, opercular bones larger, fins proportionally of the same size. From Osage River, Missouri.

I have obtained this species from Mr. George Stolley, who has made extensive zoological collections for me in the western and southern parts of the State of Missouri especially along the Osage River and its tributaries.

Cycleptus, Raf.

As in many other instances, Rafinesque has named, but neither defined nor characterised the genus to which I now call attention. He has not himself even seen the fish upon which the genus is founded, and refers to another genus a species which cannot be separated from this. Moreover the characteristics of the genus, as given by Rafinesque are not true to nature. Yet, notwithstanding these objections, I do not feel at liberty to reject his generic name; since it is possible to identify the fish he meant by the vernacular name under which it is known in the West. There is another reason why Rafinesque's descriptions of our western fishes ought to be most carefully considered and every possible effort made to identify his genera and species, the fact that he was the first to investigate the fishes of the Ohio and its tributaries upon a large scale, and that notwithstanding the looseness with which he performed the task and the lamentable inaccuracies of his too short descriptions, his works bear almost upon every page the imprint of his keen perception of the natural affinities of species, and their intimate relations to one another; so much so, that even where he has failed to assign to his genera any characters by which they may be recognized, yet, when the species upon which they are founded can be identified, we usually find that there are good reasons for considering them as forming distinct genera.

The trouble with Rafinesque is, that he too often introduced in his works species which he had not seen himself, and which he referred almost at random among his genera, thus defacing his well characterised groups, or that he went so far as to found genera upon species which he had never seen, overlooking perhaps that he had already described such types under other names.

The genus *Cycleptus* affords a striking example of all these mistakes combined together. In his remarkable paper upon the genus *Catostomus*, Lesueur describes and figures one species from the Ohio River, under the name of *C. elongatus* peculiar for its elongated cylindrical body, and for its long dorsal fin beginning half way between the pectorals and ventrals, and extending as far back as the insertion of the anal. This species Rafinesque introduces in his subgenus *Decactylus* among the genuine Catostomi, without perceiving that it belongs to his own genus *Cycleptus*. This mistake arises undoubtedly from his belief that in Cycleptus there are *two dorsals* which indeed he mentions as characteristic of this genus; but this statement is erroneous: the

rays of the dorsal are in fact, enclosed in a continuous membrane, the anterior rays only being much longer than those of the middle and posterior portion of that fin; occasionally these long rays split, and accidentally separate from the following ones, when they seem to form two dorsals.

The character of this genus, as far as the dorsal fin is concerned, consists in reality not in its division, but in its great extension along the back, and the elongation of its anterior rays. The anal is very small in proportion to the size of the fish, and inserted far back, so that the length of the abdominal cavity is greater than in the genera Carpiodes, Ichthyobus and Bubalichthys, with which Cycleptus is closely allied by the peculiar form of its dorsals. Again, Rafinesque remarks that the mouth is terminal, round and small. This requires also to be qualified. The mouth appears terminal and round only when the jaws are protruded to their utmost extent; when closed, it is rather crescent-shaped and entirely retracted under the projecting, pointed snout; the lips are covered with numerous projecting papillæ and spread horizontally.—these are moreover continuous around the angles of the mouth, so that the upper and lower lips are hardly separated by a small fold, and the lower lip is slightly emarginate in the middle, while in other genera of this tribe it is actually bilobed.

The pharyngeal bones are strong, their anterior surface being flattened and their greatest diameter being the transverse one, as in Bubalichthys and not laterally compressed and thin as in Carpiodes and Ichthyobus.

The symphysis is short and its penduncle flat and square, separated from the curved arch by a deep semicircular emargination. The teeth are also stronger and stouter than in Carpiodes and Ichthyobus, as is also the case in Bubalichthys, and they are gradually increasing in size, and relative thickness from the upper part of the arch to its symphysis, but they are much fewer and farther apart than in the latter genus. Their inner edge is transverse, rather blunt, though the middle ridge is somewhat projecting; the lower teeth are so shaped that their inner angle is hardly higher than the outer, while in the middle and upper teeth it is gradually more projecting, and from the middle of the arch upwards forms a prominent point arched outwards.

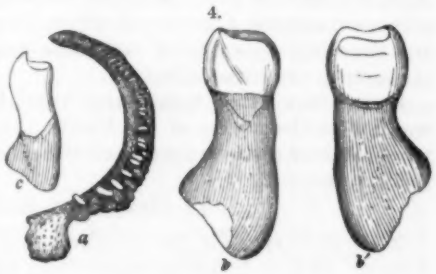


Fig. 4, *a*, represents the right pharyngeal of *Cycleptus nigrescens*

from the posterior side, *b* and *b'* being two lateral views of the lower teeth, and *c* a view of an upper tooth.

The scales are considerably longer than high, with a rather prominent posterior margin; numerous radiating furrows upon the anterior and posterior fields, some across the lateral fields; the concentric ridges of the posterior field are not only broader that those of the other fields, but instead of running parallel to the margin of the scales they are curved in concentric gothic arches between each two radiating furrows. Heckel mentions this genus under the name of Rhytidostomus, but Rafinesque's name Cycleptus has the priority. Properly it ought to be called Leptocyclus, according to its etymology, (see my Nomenclator Zoologicus: Index Universalis, p. 109,) but under this form nobody would recognize it as Rafinesque's name, I shall therefore not urge the change. I must leave it doubtful whether we have more than one species of this interesting genus. I have before me specimens from Cincinnati, kindly forwarded to me by Prof. Baird, and others from St. Louis, Missouri, for which I am indebted to Dr. George Engelmann, but they differ so much in size, those from Ohio being young and those from Mississippi rather large, that I am unable to decide whether the differences they exhibit are specific or merely characteristic of their age. In the St. Louis specimens the peduncle of the tail is shorter, the lobes of the caudal fin broader, the scales of the sides of the body less pointed behind and the caudal fin not so deeply forked. Should these differences prove specific, the name of *Cycl. nigrescens* proposed by Rafinesque may be retained for the St. Louis type, and that of *C. elongatus* for that of Cincinnati; should they be the same, the name *elongatus*, applied by Lesueur for his Catostomus elongatus, having the priority over that of Rafinesque, must be preserved for both.

The preceding descriptions show that instead of four species of *Catostomi with a long dorsal*, mentioned in Dr. Storer's Synopsis of the fishes of North America, as Catostomus elongatus and Bubalus and Sclerognathus Cyprinus and Cyprinella, we have not less than four distinct genera of this type: Carpiodes, Bubalichthys, Ichthyobus and Cycleptus, numbering together sixteen or seventeen species, fourteen of which I have been able to describe and minutely to compare with one another, having specimens of them in my own collection.

It is a fact worth mentioning that the whole of this type is wanting in the waters of the Pacific slope of our continent, from which indeed a single species of the genus Catostomus proper is known thus far.

Moxostoma, Raf.

Most authors refer the species of this genus to Catostomus proper. DeKay however refers them to Cuvier's genus Labeo,

though they bear only a remote resemblance to it. I have been unable to trace the etymology of the name Moxostoma. It may be a misspelling for Myzostoma, but in that form the name is already applied to a genus of worms.

The species of this genus contrast greatly with those of all other genera of the family of Cyprinoids, by the total absence of external openings in the lateral line, visible upon the scales. There is indeed no *row of perforated scales upon the sides of the body* to mark the main course of the system of tubes, pervading the skin in most fishes, and the pores traversing the skin which covers the skull and cheeks, as well as the lower jaw, are so minute as to escape the unarmed eye. In this respect the genus Moxostoma differs greatly from all other abdominal fishes in which the lateral line is distinctly marked by a series of tubes traversing a prominent row of scales along the sides, and extending through the mastoids to the forehead, and along the preopercle to the symphysis of the lower jaw. This total absence of an externally visible lateral line is compensated by the presence of a few deeper radiating furrows in the posterior field of all the scales.*

The longitudinal diameter of the scales exceed greatly the transverse, but the scales are imbricated in such a manner that the portion visible externally appears higher than long. The centre of radiation is placed in the middle of the scales; there are no radiating furrows upon the lateral fields, those of the posterior field are fewer and deeper than those of the anterior field; the concentric ornamental ridges of the posterior field are also much broader and farther apart than those of the lateral and anterior fields. The scales are smaller upon the anterior portion of the body than upon the sides. Another remarkable peculiarity of this genus consists in the great difference there is among the adults in the form of their fins in the different sexes. The young also differ strikingly from the adults both in form and coloration: the mouth is not surrounded by such thick lips, nor turned so far downwards, so that they may easily be mistaken for young Leuciscі, and as they are marked with a broad, longitudinal black band extending from the snout through the eye to the end of the tail, they bear the closest resemblance to the Cyprinus atronasus of Mitchill, (my Rhinichthys atronasus) and have more than once been mistaken for that species. This lateral band which I have observed in the young of all the four species of this genus, which I have had an opportunity of examining, gradually fades

* In the genus Mugil we observe another extreme in this system of tubes, every scale from back to belly, being perforated by a tube, as the lateral line alone shows them in most fishes; in other fishes, such as our *Rhombus cryptosus*, we have still another arrangement; for besides the perforations of the scales of the lateral line, there are in this fish, several rows of similar holes above and below the lateral line, and along the base of the dorsal, and below the insertion of the pectoral, all of which converge towards the upper angle of the thoracic arch and open into the sinus of Cuvier.

and finally vanishes entirely in specimens of about three inches in length. Such a young specimen of our eastern species has been described by Lesueur as Catostomus vittatus. The body of Moxostoma is elongated and somewhat compressed; though stouter than that of the Ptychostomus and Catostomus proper; its greatest depth is above the ventrals.

The head is small; the small mouth opens obliquely forwards and downwards; when open the lower jaw is quite prominent. The lips are small and transversely ridged; the lower one is slightly bilobed.

The dorsal is over the ventrals; its length considerably exceeds its height in the males; in the females these dimensions are more nearly equal. The pectoral and ventrals are more pointed and longer in the males than in the females. The lower margin of the anal fin is bilobed in the males, while in the females it is simply emarginated; in both sexes, the anal, when bent backwards, reaches the caudal.

The pharyngeal bones have a greater resemblance to those of the genus Ichthyobus, than to any other of the tribe of Catostomi; the symphysis however is shorter, and the teeth are neither so minute, nor so numerous; they increase also more rapidly in size from above downwards, and are more strongly curved inwards; their cutting edge is slanting outwards, the innermost edge rising into an acute point, which is more prominent in the middle and upper teeth, than in the lower ones. Fig. 5, *a*, repre-

5.

sents the right pharyngeal of Moxostoma oblongum, *b* one of the lower teeth in profile; *c* another in the same position; *d* the same, from the sharp side.

Former investigators, unconscious of the marked differences which exist in this genus between individuals of different sexes and ages, in different seasons of the year, have described a number of nominal species, which may now safely be reduced to their true relations. DeKay, in his Natural History of the State of New York, describes the species so common in the Eastern States, under no fewer than five different names, as Labeo gibbosus, Labeo elegans, Labeo esopus, Labeo oblongus, and Catostomus tuberculatus, and mentions it a sixth time under the name of Catostomus vittatus, given to the young by Lesueur. Dr. Storer in his synopsis of the fishes of North America, has it under five different names, as Catostomus gibbosus, oblongus, elegans, esopus, and vittatus. The oldest name applied to this fish being that of Cyp-

rinus oblongus, introduced by Dr. Mitchell in his Report of the fishes of New York, the specific appellation of *oblongus* must of course be preserved for it. Since DeKay has represented four forms of this species, I may avail myself of his figures to give an idea of its variations: *Catostomus tuberculatus*, Pl. 31, fig. 97 represents the male in the spawning season, with tubercles upon the snout, a long dorsal and a lobed anal. DeKay mentions its appearance in April. *Labeo oblongus*, Pl. 42, fig. 136, is an adult male in winter, with a long dorsal and a lobed anal, but without tubercles. DeKay observed its appearance in December. *Labeo gibbosus*, Pl. 32, fig. 101, is a younger male, with less deeply lobed anal; *Labeo elegans*, Pl. 31, fig. 100, is a young female in winter dress, with a shorter dorsal, trapezoidal anal and a more slender form. Dekay observed his specimens in October and November; *Labeo Esopus* is an adult female with a somewhat emarginate anal, broader than the preceding; *Catostomus vittatus*, Lesueur, with "a black stripe passing from the snout through the eye to the caudal fin, dividing the body equally" in the young. I have traced all these differences in specimens taken from the same pond in different seasons of the year. Lesueur, who first described Catostomus gibbosus and tuberculatus, already remarked that these species may be founded upon the two sexes of one and the same species. Instead of availing himself of this hint and ascertaining its correctness, DeKay has only increased the confusion by describing three other forms as so many additional species, and he has unfortunately been followed by later compilers. This species ranges through the States of Massachusetts, Connecticut, New York, New Jersey, Pennsylvania, and Maryland. I have obtained specimens from the Susquehannah through the kindness of Prof. S. S. Haldeman, from Carlisle, Pa., through Prof. Baird, from Chestertown and Havre de Grace, Maryland, through F. R. Williams, Esq. and Dr. Wroth. I entertain serious doubts as to the identity of the form found in Lake Champlain. The other species of the genus are Catostomus Sucetta, *Les.* (Cyprinus Sucetta, *Lacep.*), from Charleston, and other localities in South Carolina. This species occurs also in Georgia. I have received specimens from that State from Athens, through the kindness of Prof. J. Le Conte; and from the Altamaha, through G. Belknap, Esq.

The third species is the Catostomus (Moxostoma) anisurus, *Raf.*, from the Ohio, which I have found as far west as the vicinity of St. Louis (Missouri), and of which specimens have been kindly forwarded to me from the Scioto River, by J. Sullivant, Esq., from Lake Erie, by Dr. Kirtland, from Lebanon, Tennessee, by Prof. J. M. Safford, from Quincy, Illinois, by Dr. Watson, and from Milwaukie, Wisconsin, by Prof. Lapham. I have obtained a new species from the neighborhood of Mobile, Alabama, through the kindness of Albert Stein, Esq. of Springhill,

which I shall call *Moxostoma tenue*, as it differs from the others, by its more elongated form, and less prominent differences between males and females. I would unhesitatingly refer also *Catostomus congestus*, B. and G., to this genus, from the characters assigned to this species, were the lateral line not described as running straight along the middle of the side, when the absence of a lateral line is the most prominent character of the genus Moxostoma. Not having however seen a specimen, I must leave it for Messrs. Baird and Girard to determine whether it is a genuine Catostomus, as the genus is now circumscribed.

Ptychostomus, Agass.

In respect to form of body and the structure and position of fins, this genus does not differ from Catostomus proper, but may be distinguished by the following structural peculiarities. The lips are marked by transverse ridges or folds, and hardly bilobed below; they are not papiliated as in Catostomus proper. The generic name of this type is derived from this character of the lips. The head is shorter and stouter. The dorsal is longer than it is high, but in the males it is longer in proportion than in the females. The anal of the male is also broader than that of the female, and its lower margin lobed, while in the female it is trapezoidal and narrow. Such differences between the sexes do not exist in the species of Catostomus proper.

The scales are as large on the anterior as on the posterior parts of the body; their vertical diameter about as great as the longitudinal, so that the scales are nearly quadrangular with rounded edges; the ornamental concentric ridges not longer nor broader upon the posterior than upon the lateral and anterior fields; the radiating furrows few, only one or two in the posterior field, and one on each side, limiting that field from the lateral fields; those of the anterior field are more numerous, and yet not crowded. Tube of the lateral line arising in the centre of radiation or farther back upon the posterior field.

The pharyngeals are strong, their entire edge spreading like a wing, and that spreading margin is separated from the symphysis by a deep emargination. The teeth, increasing rather rapidly in size from above downwards, are more apart from one another than in the preceding genera, and arched inwards as in Moxostoma; the inner edge of the lower ones square, its inner margin rising into a broad cusp in the middle and upper teeth. Fig. 6, *a*, represents the right pharyngeal of Ptychostomus macrolepidotus from its inner surface, *b* one of the lower teeth, *c* and *d*, teeth from the middle and upper part of the arch.

I know four distinct species of this genus from personal examination, all well described and figured by Lesueur and Dr. Kirtland, viz: Catostomus Aureolus, *Les.*, Catost. Duquesnii, *Les.*, Catost. macrolepidotus, *Les.*, and Catost. melanops, *Rafin.* The Catost. Sueurii, *Rich.*, Fauna Boreali-Americani, I have not seen myself, nor the Catost. Carpio, *Val.*, but from their description, and from the figure given of the latter by Valenciennes, I am inclined to believe that Cat. Sueurii is founded upon the male of Catost. aureolus, *Les.*, and that C. Carpio is the male of C. macrolepidotus. The circumstance that I have found C. aureolus in the Lake Superior in lat. 47° would connect the range of this species from the middle western States through the great Canadian Lakes to the locality from which Dr. Richardson (now Sir John), obtained his C. Sueurii in lat. 54. DeKay's Cat. Oneida is probably also C. macrolepidotus. That it belongs to the genus Ptychostomus, the description of DeKay leaves no doubt, and his remark that the scales are *very large*, points rather to C. macrolepidotus than to Duquesnii. It cannot be a distinct species, since three species only of this genus are found within the natural boundaries of the fresh-water fauna of New York:—Catost. aureolus, Catost. Duquesnii, and Catost. macrolepidotus, one of which, C. aureolus, DeKay has himself accurately described. Rafinesque's Catostomus erythrurus is identical with Lesueur's Cat. Duquesnii. As to Catostomus melanops, *Raf.*, it is a well characterised species, which Dr. Kirtland has for the first time satisfactorily described; but the species Valenciennes described afterwards under the name of C. fasciatus from specimens sent him by Lesueur under that name, is synonymous with it, as is also his own Cat. melanotus. Judging from the form of the anal, and the position of the dorsal, I believe that Catostomus insignis, *B. & G.*, which I have not seen, also belongs to this genus, though no mention is made in their description of the character of the lips, so important in this tribe, as Lesueur has already shown. The black dot at the base of each scale, brings it near Ptychostomus melanops.

The geographical distribution of these species presents some interesting peculiarities; for three of them, C. aureolus, Duquesnii and macrolepidotus are found in the Canadian Lakes, and yet they do not cover the same areas, C. aureolus, extending chiefly northwards, Catostomus Duquesnii westwards, and C. macrolepidotus eastwards; C. melanops on the contrary, is only found in the West and Southwest, and not in the great Lakes. If, upon close examination, Catostomus insignis should prove to belong to this genus, it would furnish additional evidence that the Ptychostomi with dotted scales are the southwestern type of the genus.

Hylomyzon, Agass.

The name of this genus is a mere translation of the vernacular name of its type, the Mud-Sucker of the West, framed in imitation of Petromyzon, but expressing its habits of living in the mud. The body is stout and heavy in front, and tapers off rapidly from the shoulders towards the tail; behind the dorsal it is nearly cylindrical in form.

The short quadrangular head is broad and flat above, its sides are vertical. The eyes are of moderate size, and elliptical in form; the superorbital ridges are elevated above the general level of the head. The mouth is inferior, and encircled by broad, fleshy lips, which are covered by small granules or papillæ. The lower lip is bilobed. The dorsal is over the ventrals, and nearer the head than the tail; its height and length are nearly equal. The pectorals and ventrals are broad and rounded, the anal fin is slender and reaches the caudals. The scales are largest on the anterior portion of the body. They are slightly longer than high; the ornamental concentric ridges of the posterior field are broader and farther apart than those of the lateral and anterior fields; no radiating furrows upon the lateral fields; those of the anterior and posterior fields rather remote, about equal in number. Tubes of the lateral line arising from the centre of radiation.

The teeth are compressed, so that their sharp edge projects inwards; at the same time they are slightly arched inwards and inserted obliquely upon the pharyngeal bones. They increase gradually in size and thickness from above downwards. The masticating ridge of the teeth is transverse, compressed in the middle, and sharp; its upper and lower edges are rounded and more projecting, the inner point however projecting more than the outer one. Fig. 7, *a*, represents the right pharyngeal of Hy-

7.

lomyzon nigricans, *b* and *c*, one of the lower teeth from two sides, and *d* one of the middle teeth in profile.

There is no species in the whole tribe of Catostomi which has been described under so many names as the type of this genus. It was first described by Lesueur under the name of Cat. nigricans, from specimens obtained in Lake Erie. At the same time he described specimens from Pipe Creek, Maryland, under the

name of Catostomus maculosus, suspecting however, what is true, that this may be only a variety of the former. Soon afterwards Rafinesque described the same species from the Ohio and its tributaries, under four different names, as Catostomus fasciolaris, C. flexuosus, C. megastomus, and C. xanthopus. Again, his Exoglossum macropterum, for which he afterwards proposed the generic name *Hypentelium* is only the young of the same species; finally Valenciennes, though copying the description of Cat. nigricans and C. maculosus from Lesueur's paper, describes anew original specimens of the former species, which Lesueur had sent to the Jardin des Plantes under a new name, as Cat. planiceps. We have thus eight specific names for a single species, the only one thus far known of this genus. In order to substantiate this assertion, I ought to state that though there are no marked differences between males and females in this genus, which may lead to the establishment of nominal species, as in the genus Moxostoma, the young and adult differ greatly in their coloration, being first strongly banded transversely, then more mottled, and afterwards the bands and blotches of dark color fading into isolated specks and finally disappearing entirely, the lower fins, and the abdomen becoming in the same proportion more brightly tinged, especially in the spawning season, as the upper parts of the body grow lighter. These four stages have misled Rafinesque to distinguish four species; his C. fasciolaris, about eight inches long, with *small transversal black lines*, is described from a juvenile specimen, his C. flexuosus *from ten to twelve inches long, more plain*, is described from nearly full grown specimens; his C. megastomus, *yellowish beneath*, appearing in shoals in March, is drawn from a male in the spawning season; his C. xanthopus, *with lower fins yellowish* is a younger male; his Exoglossum macropterum is drawn from a *very young* specimen with fully protruded mouth. Thus we account for all the nominal species of Rafinesque. That he should have taken no notice of Lesueur's descriptions, is the natural consequence of the assumption upon which Rafinesque works throughout, that the fishes of our western waters differ uniformly as species from those of the Atlantic streams. The mistake of Valenciennes arose from another source. It was the habit of Lesueur to send to the Jardin des Plantes, original specimens of all his species, carefully labelled, whether he had published descriptions of them or not, and we find in the great Histoire Naturelle des Poissons, many species described by Cuvier and Valenciennes, under Lesueur's name, even though the latter had never himself published any notice of them.* Of Catostomus nigricans, Lesueur sent two dried speci-

* How honorably this course contrasts, with the race some Naturalists are running, for the questionable distinction of being the first to name species, using even all sorts of unworthy tricks to secure them.

mens to Paris from the Wabash, the labels of which seem to have been lost; at least Valenciennes, who describes them as Cat. planiceps, says he received them from Lesueur without a name, not recognising that they were original specimens of the *Catost. nigricans* of Lesueur, as the description of Valenciennes clearly shows them to be. Hylomyzon nigricans has the widest geographical distribution of all our Catostomi. It occurs in the northern and middle Atlantic States, in all the great Canadian Lakes, with the exception of Lake Superior, through all the middle western States as far as Missouri. Its southernmost localities are Lebanon, Tennessee, from which place I have received specimens through Prof. J. M. Safford, and Huntsville, Alabama, whence J. H. Newman, Esq., sent me also several specimens. Its westernmost range is in the Osage River, Missouri, from which Mr. G. Stolley has sent me quite a number. I have repeatedly and most carefully compared with one another the specimens from the remotest localities, without finding the least specific difference between them.

Catostomus.

I have retained the name of Catostomus for the type to which it was originally applied by Forster.

The body is elongated, fusiform and slightly compressed. The snout is short and blunt, and projects but little beyond the mouth, which is inferior.

The lower jaw is short and broad; the lips are fleshy and strongly bilobed below; their surface is conspicuously granulated or papillated. The head is considerably longer than high. The dorsal is large, and mostly in advance of the ventrals; its length is greater than its height. The anal fin is long and slender, and reaches the caudal.

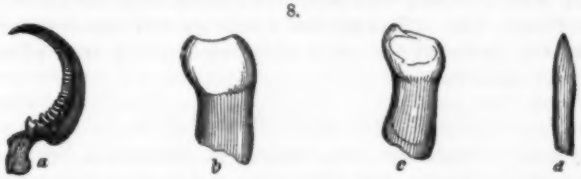
The sexual differences so conspicuous in the genus Moxostoma and Ptychostomus, are hardly to be noticed in this genus. The other fins are of moderate size, and more or less pointed.

The scales are much smaller on the anterior than on the posterior portion of the body; nearly quadrangular, with rounded angles, but somewhat longer than high; the ornamental concentric ridges of the posterior field broader than those of the lateral and anterior fields; the radiating furrows more numerous than in Hylomyzon and Ptychostomus, and encroaching upon the lateral fields, where in some species, they are nearly as numerous, as upon the anterior and posterior fields. Tubes of the lateral line wider than in Hylomyzon and Ptychostomus, extending from the centre of radiation to the posterior margin.

The pharyngeals are stout and compact, the outer margin not so spreading as in Ptychostomus; the teeth are blunter and larger comparatively than in any other genus of the tribe, increasing

more rapidly in size from above downwards, so that those of the middle of the arch are already of the same cast as those of the lower part of the comb; their crown is blunt and the inner edge rises into a blunt cusp. Fig. 8, *a*, represents the right pharyngeal

8.



of Catostomus communis, *b* being one of the lower teeth, *c* one from the middle of the arch and *d* a side view of the same.

This genus has representatives over a much greater geographical area than any other of the tribe, some are found even as far north as the fur countries of North America, others in Lake Superior; farther south they occur in all the fresh waters of the United States as far as Texas and the northern boundaries of Mexico, whence Mr. John H. Clark has obtained several new species described by Messrs. Baird and Girard in the Proceedings of the American Academy of Natural Sciences of Philadelphia, for 1854, page 27. I have myself received a new species from N. Mexico, through the kindness of Dr. Henry of the U. S. Army and another from Georgia through Prof. J. LeConte. Sir John Richardson mentions their occurrence in the Columbia River. I have myself received a new species from San Francisco, California, from my friend T. G. Carey, Jun., Esq. Valenciennes refers to this genus, a species described by Tilesius under the name of Cyprinus rostratus, from Siberia. This would be the only Catostomus from the old world. As the species of this genus are closely allied to one another and their distinguishing characters could not be plainly illustrated without figures, I will not enter into more details about them for the present and limit myself to enumerating them and describing the species from San Francisco.

The first species known is that which Lesueur has called *Catostomus Hudsonius*, the Cyprinus Catostomus of Forster. Next to it comes my *C. Forsterianus*, for which I regret having adopted that name, as it conflicts with the *Catostomus Forsterianus* of Richardson (my Cat. Aurora), an entirely different species. There are however still some difficulties about these northern species to be solved, as it remains doubtful whether there are three or four or only two species ranging from the great Canadian Lakes northward. I am unable to find any difference between Catostomus teres, *Les.* (Cyprinus teres, *Mitchill*) and his own Cat. communis, to which Cat. gracilis, Kirtland, seems also to belong, as he himself has more recently admitted. Catostomus Clarkii and Catostomus plebeius, *B. & G.*, are distinct species.

For their Catostomus congestus and insignis I must refer to my remarks under the head of Moxostoma and Ptychostomus.

Catostomus Bostonensis, *Les.*, Cat. pallidus, *DeKay*, and florealis, *Baird*, are so closely allied that I am unable to distinguish them; I have however seen only one specimen of the latter. As to Cat. Tilesii, *Val.*, it has not been seen since Tilesius described it under the name of Cyprinus rostratus, and its true affinities remain still doubtful.

Catostomus occidentalis, Agass.

This species resembles very closely C. communis, in general outline and appearance, but differs from it in the following respects. The head is less square; the profile steeper, but the snout is more pointed. The sides of the head are nearly triangular instead of trapezoidal and converge more rapidly forwards. The longitudinal rows of tubes upon the top of the head are more waved. The mouth is smaller; the hind margin of the lower lip is perpendicularly under the anterior nasal opening. The lower border of the eye and the posterior angle of the opercle are on the same horizontal line. The centre of the eye is nearer the anterior edge of the upper lip than the hind or lower angle of the subopercle. The opercle and subopercle are larger and longer and together form one-half of the side of the head. The lowest angle of the opercle is less acute, and its hind angle smaller; its waving border is directed more forwards and backwards.

The pectorals are broader; the dorsal is longer, considerably emarginated above, its last rays shorter and its upper angle more acute. The ventrals are more pointed.

The scales on the anterior part of the body are smaller.

TRIBE OF CHONDROSTOMI.

There lives in Europe a remarkable fish of the family of Cyprinoids which was first described by Linnæus as Cyprinus Nasus, and in which I recognised about twenty years ago the type of a distinct genus, *Chondrostoma*. This fish differs so strikingly from the other Cyprinoids that Heckel in his synopsis, considers it as the type of a distinct tribe, to which he ascribes the following characters:

Os inferum in aciem cartilagineam attenuatum, labiis et plica menti deficientibus; rostrum incrassatum; preoperculum ante occiput. Pinna dorsalis subelongata, analis brevis, utraque radio osseo nullo. Tractus intestinalis longissimus tenuissimus.

The cartilaginous lips, with a sharp edge of the lower lip at least and the chisel-like teeth, with a narrow flat grinding surface, supported upon pharyngeals the outer margin of which has a spoon-shaped lateral expansion, truly characterise this tribe as a natural group in the family of Cyprinoids.

Thus far, America has not been known to produce any representation of this type. I for the first time called the attention of Naturalists to its existence in our waters in my "Notice of a collection of fishes from the southern bend of the Tennessee River,"* but the scanty materials I had then in my possession did not allow me to make a thorough comparison between the representatives of the old world and those of the new, and even now I am unable to extend my investigations to the Asiatic and African species described by Buchanan, McClellan, Sykes, Russell and Valenciennes. But even between the American and European members of this tribe, most of which I have now before me, there are marked differences and striking analogies. In the first place, I would remark that the genus Exoglossum of Rafinesque, which is entirely peculiar to North America, though placed near Catostomus by all ichthyologists who have had an opportunity of examining it, in reality belongs to the tribe of Chondrostoma, the very peculiar shape of its mouth being only the extreme of the feature characteristic of that genus and arising from the reduction and discontinuity of the lower lip near the symphysis of the two branches of the lower jaw and the great projection of the symphysis itself. The pharyngeal teeth moreover have no resemblance to those of Catostomus, either in their form or in their arrangement, but approximate closely the common type of Leuciscus and Chondrostoma, between which they are intermediate.

The genus Pimephales of Rafinesque, which, like Exoglossum, contains also exclusively American species, next deserves to be noticed here. Since Rafinesque, Dr. Kirtland seems to be the only ichthyologist, who has observed the type upon which this genus was founded. We find an excellent figure of it, accompanying his paper upon the fishes of the Ohio and its tributaries, published in the 3d vol. of the Boston Journal of Natural History. This genus seems at first to resemble more the type of Leuciscus than that of Chondrostoma by its general form, and yet the attenuated, sharp, somewhat truncated lower lip, and the thickened snout leaves no doubt as to its real affinity with Chondrostoma. The fish described by Dr. Kirtland as Exoglossum dubium, of which Valenciennes' Exoglossum spinicephalum is the male in the spawning season, is another representative of this tribe, still more approximating the European genus Chondrostoma, but differing from it, in having only four pharyngeal teeth on each side, instead of six, and which I shall call *Compostoma*. Finally, among the fishes collected by the U. S. Exploring Expedition, under the command of Capt. Wilkes, there is a species found in the Columbia River, coming nearer to Heckel's genus Chondrorhynchus, than to my Chondrostoma, which however constitutes another genus peculiar to the Pacific slope of North America, which I shall call *Acrocheilus*.

* Printed in this Journal, vol. xvii, 2d ser. p. 357.

It appears thus that far from being deficient in representatives of the tribe of Chondrostomi, North America has a greater number of them and more diversified ones than Europe, belonging to four distinct genera: Exoglossum, *Raf.*, Pimephales, *Raf.*, *Compostoma*, Agass., and *Acrocheilus*, Agass.; to which must be added two other new genera to be described hereafter, founded also upon North American species: *Hybognathus*, Agass., and *Hyborhynchus*, Agass. I am unable to say whether the genus *Cochlognathus*, B. and G., belongs to this tribe or not, as I have had no opportunity of examining it.

Acrocheilus, Agass.

The type of this genus has a general resemblance to the type of my genus Chondrostoma, inasmuch as the mouth opens transversely under the snout, and has a hard cartilaginous or rather horny edge. But it differs from that genus in having a solid rim along the upper lip similar to that upon the lower, and in the character of its scales, which resemble more those of the group of Barbus, than those of the common type of Leuciscus or Catostomus.

As a genus I would characterise it by the peculiar structure of the edging of the mouth, which in the lower jaw constitutes a transverse broad flat plate, very similar in appearance to the dental plates of Myliobates, being thicker along the outer edge and tapering gradually along the inner edge. This transverse plate is square and cut at right angles externally towards the symphysis of the two jaws. In consequence of this peculiar structure of the margin of the mouth and its armature, the lower jaw is as it were cut transversely, and has in no degree the rounded outline about the symphysis of its branches which is observed in most Cyprinidæ. The membranous fold which extends from the suboperculum along the interoperculum towards the symphysis of the lower jaw is limited by a deep furrow which terminates somewhat behind the horny plate of the lower jaw. Along the inner edge of the intermaxillary bone there is a similar transverse bony plate which is, however, much narrower and rounded, folding over that of the lower jaw when the mouth is shut. Sideways and above, the intermaxillaries are surrounded by a fleshy lip which is bent forwards at the angle of the mouth to unite with the edge of the horny plate of the lower jaw. The upper maxillary bone forms a slight projection behind the angle of the mouth in a depression arising from a membranous fold upon the sides of the lower jaw, and below and behind the first suborbital bone. There is not the slightest rudiment of a tentacle in the angle between the lower termination of the intermaxillary and upper maxillary. But what is particularly striking in the structure of this fish is the circumstance that the horny covering en-

circling the mouth is deciduous, at least in specimens preserved in alcohol, showing that the attachment of this indurated edge is not very close. The surface to which the horny plate of the lower jaw was attached appears fibrous upon the removal of that plate, and the fibres run in a longitudinal direction up and down. The tissue of the plate itself is also fibrous and the fibres have the same longitudinal direction throughout its thickness, so that the plate breaks very readily at right angles with its own greater diameter.

The nostrils, two on each side as in all Cyprinidæ, consist of a tubular opening in advance and a large crescent-shaped opening behind.

The opercular apparatus and the branchiostegal rays, present no peculiar characters. The branchiostegal membrane however unites with the skin under the chin on the anterior margin of the humerus, so that the branchial opening does not extend to the sides of the tongue bone.

The dorsal begins opposite the insertion of the ventrals, which are themselves somewhat nearer to the anal than to the pectorals. The dorsal extends as far back as the anterior margin of the anal. It has three small rays in advance of the longest simple ray which is followed by ten branching rays, the last of which is properly a double ray.

All these rays are deeply divided longitudinally and transversely articulated. The caudal is very powerful, and remarkable for the many simple rays which it has along the base of its two lobes, there being seven above and seven below, gradually increasing, so that the longest reaches nearly half the length of the longest simple ray which edges the fin above and below. The inner rays are all deeply divided longitudinally and transversely articulated. The number of rays in the upper and lower lobe is equal, eight in both. There seems however to be a middle ray, so that properly speaking there are seven rays in the upper lobe, one in the middle, and eight in the lower lobe.

The tail is deeply furcate. When the fin is shut, the innermost rays overlap each other, so that the caudal appears much narrower than when fully expanded, but the outer rays in both lobes remain in one plane, and do not overlap each other at all. The anal consists of two simple short rays in advance of the long simple one followed by nine articulated rays which, when the fin is closed, overlap each other; so much so that the fin appears much narrower when bent backwards than it is in reality. My attention not having been called formerly to the manner in which the fins shut until I began to study the Balistidæ, I am unable to say how far in various families, the closing of the fins varies; but it is a point to which the attention of Zoologists should be directed in future, as it will no doubt afford interesting characters

in addition to those exhibited by the structure of the rays themselves. As far as I can ascertain, it has been admitted among ichthyologists, that the change of form in the fins arose from the rays being brought close together, or stretched asunder; I find, at least, no mention in any description, of rays overlapping each other, as I have shown it to be the case among Balistidæ, and as is also the case among many others. In the Scomberoids, for instance, the rays of the vertical fins are remarkably spreading when contrasted with those of the Balistidæ, or those of the genus Acrocheilus described here. The ventrals are rather large, somewhat similar in their rounded form and the thickness of their rays, to the ventrals of the genus Tinca; the first ray especially is thick and simple. It is followed by eight articulated rays. The pectorals are also somewhat rounded, but not so much as the ventrals, the upper angle projecting more. Their first ray is also thick and simple, and is followed by sixteen articulated rays gradually tapering, the last of which, however, are simple. In its general form, the fish upon which this new genus is founded, has considerable resemblance to the European Chondrostoma Nasus, and I should not be surprised at all if, upon a superficial examination, it had been identified with it, notwithstanding the generic and specific differences, to which I have already alluded. The scales, however, present a striking difference. They have not, as in Chondrostoma, the ordinary type of Leuciscus, but resemble rather the scales of Barbus in their elongated form, their small size, their many radiating furrows diverging in every direction, and their ornamental pigment cells which are especially numerous along the posterior margin. The centre of radiation is far in advance of the centre of form. The lateral line arises above the posterior and upper angle of the operculum, and is first slightly bent downwards, so that it follows in its course upon the side, a direction nearer the abdominal margin than the back; but upon the tail it is strictly upon the middle of the side. The tubes of these scales arise in the middle of the anterior field, and taper towards the middle of the posterior field, where they terminate. The scales along the back, upon the neck, between the pectorals, and along the lower margin of the abdominal cavity, are much smaller than upon the middle of the sides. There is a naked space behind the pectorals in which the muscular swelling of the base of that fin is received, when the fin is bent backwards. There is also a narrow smooth space above the ventrals; along the base of the dorsal and anal the scales do not extend quite to the base of the rays, but upon the caudal they cover their base completely and even extend somewhat along the sides of the middle rays.

Water pores besides those of the lateral line, are very distinct upon the neck in advance of the scales. The whole surface of the skin covering the skull seems also to be perforated by a set

of smaller pores, but larger ones follow the margin of the preoperculum, and the lower jaw as well as the suborbitals and mastoid bones.

Unfortunately the two specimens collected in Columbia River are deprived of their intestines, and in one of them only, were the pharyngeal bones, with their teeth, preserved; but these afford further evidence of the correctness of my view in considering these fishes as a type of a distinct genus peculiar as far as is now known to the northwest coast of America. There is but a single row of teeth and only five teeth in that one row on the left and four on the right side. The isolated teeth stand on a cylindrical peduncle swelling into an oblique club-shaped crown, which is elongated externally into a sharp hook, but the inner surface is cut obliquely like the incisors of Rodents, and present a flat grinding surface resembling closely the dentition of Chondrostoma and Chondrochilus, differing however in the more club-shaped form of the teeth, and the sharp terminal hook, and also the smaller number of teeth in one row. Fig. 9, *a*, represents

9.

the right pharyngeal of Acrocheilus alutaceus seen from behind, *b* the same seen from its inner margin, *c* one tooth in profile from its upper side, *d* another from its lower side, and *e* the same from the inner side to show the grinding surface. As a further resemblance to the genus Chondrostoma, I should mention the circumstance, that the peritoreum is also black.

Acrocheilus alutaceus, Agass. and Pick.

Caught at Willamet Falls, and in Wallawalla River. Nose prominent and rounded.

Tail rather slender. Caudal large. Dorsal much larger than the anal. The color light brown above, (there being a white and very fine line on the edge of each scale,) blending into yellowish brown upon the sides, and passing into pure white upon the abdomen. Gill-cover golden brown. Dorsal and caudal of the same color as the sides of the body. Pectorals orange, gradually paler towards the base. Ventrals as the pectorals, but more uniformly orange. Anal also orange, but more bright and reddish. It occurs in the rapids and falls of the River. Is caught by the natives while fishing in the Falls for Salmon.

(To be continued.)

Art. XIII.—*Thoughts on Solution and the Chemical Process;* by T. S. Hunt.

By solution, as distinguished from fusion or volatilization, we understand in chemistry the production of a homogeneous liquid by the combination of two or more bodies, one of which must itself be in a liquid state, while the others may be liquid, solid, or gaseous. The solvent action of acids and alkalies upon bodies insoluble in water is by all admitted to be chemical in its nature; but according to Leopold Gmelin, "mixtures of liquids, and solutions of solids in liquids, (as of acids, alkalies, salts, oils, etc., in water and alcohol,) are by Berzelius, Mitscherlich, Dumas, and others of the most distinguished modern chemists, regarded as not chemical unless they take place in definite proportions." "Mitscherlich attributes such unions to *adhesion*, Dumas to *a solvent power* intermediate between cohesion and (chemical) affinity, and Berzelius refers them to *a modification of affinity*, while proper chemical combinations according to him result not from affinity, but from electrical attraction."—(*Gmelin's Handbook*, English ed., vol. i, p. 34.)

The learned author of the Handbook objects to these views that "they restrict the idea of a chemical compound within too narrow limits," and he elsewhere implies that the force which produces solution is a weak degree of chemical affinity. (Id. vol., p. 70.) The judicious Turner also speaks of ordinary solutions as instances of chemical union;* and Mr. J. J. Griffin has insisted upon the same view.† As these writers have not however sufficiently dwelt upon the important principle, rejected by so many names of authority, that *all solution is chemical union*, we propose to offer some considerations upon aqueous solution, and endeavor to show that the process presents all the phenomena of chemical combination. First, in the fact that the resulting saturated solutions are perfectly homogeneous; secondly, in the condensation and more or less perfect identification of volume observed in the process;‡ (some anhydrous salts dissolve in water without increasing its volume.) Thirdly, in the change of temperature which attends the process; thus oil of vitriol, hydrate of potash, and many anhydrous salts evolve heat when dissolved in water, while sal-ammoniac, nitre, and many hydrous salts produce cold by their solution. Fourthly, in the change of color which attends the solution of some salts, as the chlorids of nickel, cobalt, and copper.

* Elements of Chemistry, 7th ed., p. 139.

† L., E. and D. Phil. Mag., 3d Series, vol. xxix, p. 299.

‡ See my paper, *Considerations on the Theory of Chemical Changes, etc.*, this Journal [2], xv, p. 228, L., E. & D. Phil. Mag. [4], v, 526, and Pharm. Centralblatt, Leipzig, 1853, 849.

It must not be forgotten that the liquid state of these aqueous combinations is often an accident of temperature; alum and the rhombic phosphate of soda are liquids at 212° F., and bi-hydrated sulphuric acid is a crystalline solid below 46° F. The ease with which many of these compounds are destroyed by evaporation, and even by changes of temperature, is not to be urged as an objection to the chemical nature of the union. We need only compare the corresponding silver salts with the chlorid and iodid of gold, or the hydrochlorates of morphia and ammonia with those of caffeine and piperine, which lose their acid by a gentle heat, to learn how variable is the stability of admitted chemical compounds. Chemical affinity may be very feeble in degree.

According to Gay-Lussac one part of oil of vitriol will absorb from air saturated with moisture, fifteen parts of water, or more than eighty equivalents; terchlorid of arsenic requires eighteen equivalents of water to dissolve it, and the saturated solution unites with as much more water, evolving heat and forming a stable solution.* According to the experiments of Mr. Griffin in the paper cited above, the condensation which takes place in the solution of the acid is still perceptible with 6000 equivalents of water to one of SO_3. There appears however to be with many bodies a limit beyond which the affinity for water is satisfied, and the liquids being then mechanically mixed, gradually separate by reason of their difference in density, as is observed in dilute alcohol, and probably in some saline solutions† and metallic alloys.

Solution is a result of that tendency in nature which constantly leads to unity, condensation, identification. I have elsewhere with Kant defined chemical union to be interpenetration, but the conception is mechanical, and therefore fails to give an adequate idea. The definition of Hegel, that *the chemical process is an identification of the different, and a differentiation of the identical.*‡ is however completely adequate. Chemical union involves an identification not only of the volumes, (interpenetration mechanically considered,) but of the specific characters of the combining bodies, which are lost in those of the new species. Such is equally the case in aqueous solution, and we may say that all chemical union is nothing else than solution; the uniting species are as it were, dissolved in each other, for solution is mutual.

* Penny and Wallace, L., E. & D. Phil. Mag., Nov., 1852, p. 363.

† See Gmelin's Handbook, Eng. ed., vol. i, p. 111. Gmelin throws a doubt upon these experiments; but the satisfactory results obtained on a large scale, in applying this principle to the rectification of spirit of wine by a recently patented process, were communicated to the American Association for the Advancement of Science, at Washington in May, 1854, by Dr. L. D. Gale.

‡ Stallo's Philosophy of Nature, p. 453. See also p. 67, where Stallo insists upon the same view. To Hegel belongs the merit of having first among modern philosophers obtained a just conception of the nature of the chemical process, although in its application he was misled by the received terminology of the science.

Solution being then identification, the discussion as to whether metallic chlorids are changed into hydrochlorates when dissolved in water, is meaningless. Such a solution is a unity, in which we can no more assert the existence of the chlorid or of water, than of chlorine, hydrochloric acid, or a metallic oxyd, although these and many others are conceivable results of its differentiation. If the solution be one of chlorid of potassium, evaporation resolves it into water and the chlorid, but if chlorid of aluminum, it is decomposed by boiling into water, hydrochloric acid, and alumina, or in the case of the magnesian salt, into hydrochloric acid and an oxychlorid.

The precipitation of the sulphates of cerium, lanthanum and lime from their solutions by heat, and of most other salts by cold, is chemical decomposition or differentiation. Dilution may also effect decomposition in solutions; we have already said that the combination of terchlorid of arsenic $AsCl_3$, with 36HO is stable at ordinary temperatures, but a further addition of water causes the solution to divide into aqueous hydrochloric acid, and crystalline oxyd of arsenic. The precipitation of chlorid of antimony, and many salts of bismuth and mercury by water, is an analogous process. This decomposition of the solution of chlorid of arsenic is an example of what is called double elective affinity, (*attractio electiva duplex*,) and is generally explained by saying that the attraction of arsenic for oxygen, and that of chlorine for hydrogen, enable the chlorid and water to decompose each other. But these elemental species do not exist in the solution, although they are possible results of its decomposition, and to explain the process in this manner is to ascribe it to the affinities of yet unformed species.

I have elsewhere asserted that double decomposition always involves union followed by division,* although we cannot in every case arrest the process at the first stage. Under some changed conditions of temperature and pressure, the decomposition may be the counterpart of the previous union, and thus reproduce the original species, as in the case of mercuric oxyd, which is decomposed into mercury and oxygen at a temperature a little above that at which it was formed. When the division takes place in a sense different from the union, giving rise to new species, we have double decomposition. In the case of chlorid of arsenic, the aqueous solution exhibits the first stage of the process. A similar condition of unstable union is observed in many other instances; thus binoxyd of manganese gives with cold hydrochloric acid, a brown solution, but the combination is by a gentle heat resolved into chlorine gas, and a rose-red solution of protochlorid of manganese. So a mixture of equivalent parts of

* Consderations on the Theory of Chemical Changes, etc., cited above.

chlorid of benzoyl and benzoate of soda combines at a temperature of 130° C., to form a limpid solution, and it is only on raising the temperature that the precipitation of sea-salt indicates the commencement of that decomposition which yields at the same time anhydrous benzoic acid.* It is only when looked upon as a momentary combination followed by a decomposition, that the theory of double decomposition becomes intelligible, and in accordance with known facts.

From the narrow limits of temperature which often include the two processes, and from the ease with which light, warmth, friction and pressure excite the decomposition of such bodies as the chlorid of nitrogen, the nitrite of ammonia, the oxyds of chlorine, and the metallic fulminates, we may conceive that within still narrower limits, and under conditions as yet undefined, many bodies may exhibit affinities for each other, which are reversed by a very slight change of condition. In this way we may explain many of those obscure phenomena hitherto ascribed to *action by presence* or *catalysis.*

Montreal, Nov. 10, 1854.

ART. XIV.—*Correspondence of M. Jerome Nicklès, dated Paris, Nov.* 3, 1854.

Obituary.—The patriarch of French Botanists, M. Brisseau de Mirbel, has just died at an advanced age. For many years he had been dead to science as well as to his family and friends. He came out, like many others illustrious in science, during the French Revolution, and was active in promoting the progress of the Science of Botany at the commencement of this century. He first introduced into France the study of the microscopic anatomy of plants. The microscope which more than a century before had furnished important results to Grew and Malpighi, had long been left, in France especially, among physical apparatus, and was hardly applied to the Natural Sciences. M. de Mirbel, engaged in this fertile line of research, with very imperfect instruments, and from the commencement of his investigations in 1801, aimed to found the department of the comparative anatomy of plants, by studying for this object a number of families of acotyledonous and monocotyledonous plants.

In early youth he devoted himself with success to painting, and was intimately acquainted with the celebrated artist Girard. His knowledge of painting was afterwards of great use to him, enabling him to sketch well what he observed, as may be seen especially in his researches on the structure of the seed and embryo of different plants of the family of Labiatæ, etc.

M. Mirbel was a member of the Academy of Sciences from the year 1808. His work entitled "Eléments de Botanique" in 1815, led to his

* Gerhardt, Ann. de Ch. et de Phys. 3me Seric, tom. xxxvii, p. 299.

appointment as Professor in the Faculty of Sciences at Paris, succeeding Desfontaines. This was the first period of his scientific life. His intimate friend Duke Decaze having been named Minister of the Interior (in 1816), he accepted the position of general Secretary, which he held till 1824. If he did not publish works during this time, he performed an important service to science by using his influence in bringing back from exile men of science who had become victims of political vicissitudes at the Restoration; and through him also funds were given to the Museum of Natural History, to render the institution useful to travelling naturalists.

Returning to private life, he took up again his researches in physiology. His new labors possessed a novelty, an exactness, and perfection, which was hardly expected of a savant, who had been so long a stranger to the progress of the science. What was especially surprising, was the profound difference between his new views and those of his youth, and also his noble frankness in acknowledging any inexactness or too positive assertions in his former works. His memoirs on the development of the ovule, on the structure of the Marchantia, on the formation of the embryo, on the arrangement and mode of formation of the tissues in the stems and roots of monocotyledonous plants, on the cambium, were elaborated in this new period; and they were the occasion of spirited discussions with M. Gaudichaud, then young, whom science has lost during the present year. M. Mirbel did not long continue in this new career. He fell into imbecility, and continued in this state until his death.

Astronomical Refraction.—A memoir by M. Faye, in which he endeavors to show a defect in the existing theory of astronomical refraction and proposes a formula for correcting it, has led to an interesting discussion which has already continued two months. All the astronomers and the principal physicists have taken part. M. Biot does not adopt the innovation, and his third memoir has just been read, opposing the view that it is necessary to add to the theory the coefficient of terrestrial refraction. M. Faye has nevertheless many partisans, and the issue of the discussion does not appear doubtful.

Constitution of the Sun; Solar Magnetism.—Mr. Thomson, one of the physicists, who with Carnot, Clapeyron, Joule, Meyer and others, have most largely contributed towards establishing the relations between heat and mechanical force, has extended his researches to the heat emitted by the sun; and he observes that this heat corresponds to a development of mechanical force, which, in the space of about 100 years is equivalent to the whole active force required to produce the movement of all the planets. The author examines successively the different sources of heat, and ends by concluding that the solar heat can have no other than a meteoric origin, and that it results from the motion of meteors which fall into the sun—an idea first put forth by M. Waterston at the meeting of the British Association at Hull. Whatever may be the value of this hypothesis, we may ask whether it would not be more simple to admit that the solar heat proceeds simply from the rotatory movement of the sun; Mr. Thomson admits himself that the rotation is necessary to the production of the heat. It is known that the sun moves on its axis, and what use is this intervention of meteorites, which nothing justifies?

This idea of deriving the heat from motion, which was rejected more than thirty years ago, suggests the hypothesis which assigns an analogous origin to terrestrial and hence to planetary magnetism, an hypothesis of which we have spoken on several occasions in this Journal.* But, at that time, the question of solar magnetism was still under discussion, which, researches undertaken by M. Secchi, director of the Observatory at Rome, have now established on evidence. The sun, which is a source of heat, and a source of light, is then a source also of magnetism; heat, light, electricity and magnetism, have then a common origin—matter in motion.

Optics—Manufacture of Glass for Objectives.—In the manufacture of glass for the lenses of telescopes, the vitreous mass when brought to a liquid state in a crucible, is stirred in order to render it homogeneous, and to expel the air it may enclose. But this result is never fully attained; there are always numerous streaks in the mass, which cause the loss of a large part of the material, and hence the difficulty of obtaining lenses of large dimensions.

M. Peyronny, captain in the corps of Engineers at Cherbourg, proposes to avoid these difficulties, by giving the crucible a rapid rotatory movement around a vertical axis; the centrifugal force tends to bring all the bubbles of air about the centre of the melted mass, whilst the streaks caused by the stirring mostly disappear, and those remaining are circular and feeble, and also little objectionable if the axis of the mass be made the axis of the lens.

Polarization of the Atmosphere, &c.—There are several kinds of apparatus for exhibiting the phenomena of polarization. Besides the polariscopes of Biot, Arago, Savart, Guérard, Delezenne, Soleil, there are the polariscope of Babinet and the chromatic clock of Wheatstone: but we have not, properly speaking, an apparatus for measuring easily and rigorously the quantity of polarized light contained in a ray or in a given luminous field. M. Bernard, Professor of Physics at Bordeaux, has resolved this problem in a manner satisfactory to the most critical physicists of the Academy of Sciences of Paris, and those at the recent session of the British Association, where his apparatus was exhibited. Through the assistance of the theories of Fresnel and Arago, and also profiting by the discoveries of Babinet and Beer of Bonn, M. Bernard has constructed an instrument of extreme delicacy, which is managed with great ease, and requires but two minutes for an observation.

The same physicist has constructed a *Refractometer*, for determining, to the 4th decimal, the index of refraction of solid bodies, and for liquids arranged as a medium with sensibly parallel surfaces. He has also contrived a *universal photometer*, of which we shall give details in another communication.

Microscopes for Micrographic demonstrations, by Nachet.—Those who use the microscope in instruction, know the difficulty of adjusting in the field of vision, the objects to which they would call attention, and are aware how convenient it would be could they exhibit to several students at once, the part of an object to which attention may be directed with a needle. The microscopes of Nachet realize this object, and have been employed by Prof. Milne Edwards for a year in his lec-

* January 1854, p. 116, and November, 1854, p. 386.

tures at the Faculty of Sciences of Paris, and the Museum of Natural History. In one of these instruments, made for anatomical demonstrations, two persons may see at once the same object. The two images are formed by a prism whose transverse section is an equilateral triangle, which is placed immediately below the objective in such a way that its edge shall be perpendicular to the optic axes of the lenses. Each of the two faces of the prism reflect the image of the object at such an angle of incidence that this image passes at right angles to the surface opposed; finally the ray of light, thus turned from its direct course, meets a second prism whose surfaces are parallel to the first, but whose edges form with the edges of that a right angle. The image reversed behind the objective is thus righted by the first prism, so that the observer can direct his needles towards any part of the object without difficulty.

In other microscopes, three or even four images are obtained through as many ocular tubes, by substituting for the ordinary prism below the objective, either three reflecting prisms placed around the optical focus of the instrument, or a quadrangular prism acting as a multiplying prism. The loss of light from these additions is less than would be supposed, and Milne Edwards and other micrographers say that such instruments have been very useful in their demonstrations.

Aluminium and the Alkaline Metals.—The persevering efforts of M. H. Sainte Claire Deville and M. Bunsen, lead us to hope that aluminium will soon become a useful metal. The last advance has been made by means of the pile causing it to act on chlorid of aluminium. It is an important step; but still the process is expensive. Deville, not expecting to reach a cheaper method by means of the galvanic battery, has endeavored to use the old method by sodium, and has sought to reduce the cost of preparing this last metal. He can now prepare this metal at a cost of 25 francs the kilogramme ($2 15 cts. the pound avoirdupois.) The following is the process:—Mix together for a thousand parts,

Dried carbonate of soda,	714 parts.
Carbonate of lime,	108 "
Pulverized charcoal,	178 "

Reduce the whole to a paste with oil, and put it into an iron retort, like that of a mercury bottle. A musket barrel two decimeters long is fitted to the extremity, to which is adapted one of Donny and Mareska's receiving vessels. The retort and barrel are heated to redness: the sodium is immediately reduced, volatilizes, and is condensed in the recipient.

The only peculiarity of this process is the carbonate of lime, which serves to prevent the mixture from entering into fusion: it was through a perusal of the memoir of MM. Donny and Mareska, remarking that these chemists recommend the use of crude tartar which contains lime, that Deville was induced to study out the reason for this preference; he soon discovered it, and proved that he was right, by adding to the ordinary mixture 15 per cent. of chalk.

M. Deville has also prepared *metallic chromium*, by using the method mentioned in a preceding number of this Journal, and which depends on producing a very high temperature in an ordinary furnace. The

mixture employed is oxyd of chrome and carbon, the former in slight excess. The metallic chromium resulting was of extraordinary hardness; it scratches glass like the diamond.

Manufacture of Alcohol.—The disease of the vine and the consequent dearness of wine, has directed attention to different methods of obtaining alcohol without the aid of the grape, or the cereal grains, which last the French government protects, as their use diminishes the amount of food and raises prices. Recourse has been had to the juice of the beet, which has given rise to an extensive establishment under M. Leplay, to which I alluded in a former note on the sugar of barytes. But as this use of the beet is at the expense of the sugar, and would finally turn the sugar manufactories into distilleries, we now hear of the alcohol of Indian corn, alcohol of couch grass ("chiendent"), alcohol of asphodel, which have begun to be manufactured in the colony of Algiers. Quite recently, M. Arnoult has applied to the same purpose the fact discovered by M. Braconnot of Nancy, and which consists in transforming wood into sugar by means of sulphuric acid. M. Arnoult has observed that poplar wood gives the best results, affording 79 to 80 per cent. of sugar to be converted into alcohol. The wood is reduced to coarse saw-dust then dried at 100° C; after cooling sulphuric acid is added in small portions, taking care that the material does not become heated. It is well mixed, and after repose for 12 hours, it is triturated until the mass, before almost dry, becomes quite liquid so as to run. This liquid, diluted with water, is made to boil; the acid is saturated with chalk, and the liquor after filtration is subjected to fermentation; when the alcohol is distilled off by the usual process.

The quantity of sulphuric acid employed should not be less than 110 parts for 100 by weight of the dry wood. The author hopes to diminish the quantity of acid, and is engaged at this time on this part of the process. We cannot say that the process will be economical.

Crystallizations.—We have just seen at the Sorbonne, in the laboratory of M. Dumas, a magnificent collection of artificial crystals. The principal types of crystallized compounds are represented among them, and the crystals are of high finish and transparency. Artificial crystals are usually imperfect on one side; but the author of this collection has obtained crystals that are wholly without defects. There are transparent crystals of hyposulphite of lime of perfect symmetry; of the double sulphates, monoclinic in form, of the magnesia series $SO^3RO+SO^3KO+6HO$; the different alums; the double chlorids; the different salts of copper with the fatty acids of the homologous series $C^nK^nO^4$, &c. &c. The owner of this fine collection is a German chemist, M. Stephany, who gives his time and labors wholly to this business and who devotes himself to his crystallizations with a patience quite Germanic. M. Dumas employs him in his laboratory and has given him a commission to form a collection of the principal artificial crystals—an example which should be followed. Now that crystallography has become a part of chemistry, it is indispensable that artificial products should be studied with the care which mineralogists have devoted to native crystals. The many misunderstandings will be avoided when the forms shall have been referred to types whose exact composition is known, and whose crystallized form can be verified.

This undertaking is specially interesting for scientific instruction in France, since the new programme of Chemistry which has just been prescribed to the Professors of the Faculty of Science, contains questions relating to isomorphism, polymorphism, isomeromorphism, and in general all that relates to the relations between chemical composition and crystalline form.

Introduction into France of a new species of Silkworm.—The "Société Zoologique d'Acclimatation," alluded to in a former communication,* is highly prosperous. It has made numerous laudable attempts to acclimate useful animals from different parts of the globe, and to domesticate wild animals. Although too recently formed to pronounce on the full success of its endeavors, it is already in possession of facts which give great hopes. Of these, is the acclimation of the Bombyx Cynthia ("chenille du ricin") a silkworm of India, which, according to Roxburgh, furnishes a silk so firm that clothes made of it will last a life time. The honor of having introduced this Bombyx belongs to M. Milne Edwards, the Dean of the Faculty of Sciences of Paris, who has made experiments also on the hatching of the eggs of these silkworms.

As the Ricinus (Castor-oil plant) grows with wonderful facility in the south of France and Algiers, attempts have been made for a long time to introduce the Bombyx Cynthia. But the rapidity with which the eggs hatch, and the short duration of the period of the cocoon state, has seemed to render it difficult to carry the animal from India to Europe. A series of circumstances has led to a triumph over the difficulties, and some decisive trials place the success beyond doubt. The cocoons have a russet color. At one extremity there is an opening which the caterpillar reserves in order to facilitate its escape on passing to the butterfly state. The threads of the cocoons are so agglutinated that at first it seemed impossible to divide them; but M. Guerin Menneville has succeeded in proving the dividing possible after boiling the cocoons in alkaline water. There are experiments now in progress at Algiers, to ascertain the value of the silk per acre of Ricinus compared with that of an acre of mulberry.

Industry and Agriculture of Algeria.—We cite some facts from an interesting report made by Marshall Vaillant, Minister of War, on the agricultural and industrial condition of our French colony of Algeria in 1853.

Fertility of Algeria.—In 1853, Algeria furnished to France over a million hectoliters (over three millions of bushels) of cereal grains, valued at fourteen millions of francs. It has produced the tender wheat ("blé tendre") of the best quality weighing 86 to 88 kilograms in place of 76.

Industry in Silk.—The superior quality of the Algiers silk, attested by two medals at the London exhibition and by the price it brings at Lyons, leaves no doubt that Algeria must take a prominent place among countries which derive their principal wealth from the production of silk. In 1853, three hundred and thirty-five persons ("éducateurs") have collected in the single department of Algiers 14,000 kilograms of cocoons. Plantations of mulberry are daily multiplying and the silk industry is constantly increasing.

* This Journal, vol. xvii, page 414.

Cultivation of Madder.—The madder of Algiers is known to be more highly esteemed than that of Cyprus. It follows from calculations made from several columns that the cost is 70 francs the 100 kil., while it brings 140 to 155 francs.

Cochineal.—The success of the cochineal insect at Algiers is no longer doubtful. A hectar planted with 13,000 feet of cactus gave a crude product of 10 to 12 thousand francs of which only 2000 should be set down for expenses: there are actually 29 "nopaleries" (plantations of cactus) and 500,000 feet of cactus.

Cultivation of Cotton.—The cotton of Algiers took 11 prizes at the London Exhibition. The two varieties which grow best at Algiers are those which are of the highest price, (because America can furnish only 30,000 bales [?]) and also which give the largest return. Europeans and Arabs are engaged in the work, and during a single year the plantations of cotton have increased ten-fold.

Oils.—The olive tree in Algeria grows to the height of our largest forest trees. Certain countries, and especially Kabylia, are covered with it. Since 1852 the commerce in oil has rapidly increased. Europeans have put up well managed establishments among the mountains, and students in our nurseries from among the native population are taking lessons in grafting the olive trees. In 1853, although the product was below the mean, the amount exported was 2,914,430 kilog.

Government Nurseries.—The objects of the government nurseries are to produce a large number of young trees and give them to the colonists at a small price, and experiment on the cultivation of exotic industrial plants and endeavor to acclimate them in Algiers. To them we owe the cultivation of cotton, madder, the trades in cochineal and silk; and probably also the acclimating of the coffee and tea plants. Through them the oases have received the rice of China, which grows at the foot of the palms without requiring special care.

Value of the Forests.—The forest country of Algeria as now known, comprises about 1,200,000 hectars. Species of Cork Oak constitute a large part of these forests, and already 12,000 hectars of this wood have been explored. On the line of the Tell there are forests of cedar some of which are 4 or 5 meters in circumference; there is good timber for the construction of ships, and also other kinds, like the pine, juniper, arbor vitæ, olive, black walnut, etc., which do not yield in quality to the trees of America.

Metallurgical and Mineralogical Industry.—The exploration of the mines of copper have been active in consequence of a temporary permission of exportation given to foreigners. There were exported 3,111,516 kilog. of argentiferous lead ore. Some furnaces established within a few years produce steel rivalling that of Sweden. Quarries of marble and translucent onyx are opened which still bear marks of the labors of the Romans.

Coral Fishery.—One hundred and fifty-six vessels in the coral fishery explored in 1853 the vicinity of Bone and Calle and collected on an average 230 kilograms per boat. At the price of 60 francs per kilogram, the value of the fishery was 2,152,800 francs. Large banks have recently been discovered on the coasts of the Province of Oren.

We stop here with our citations. The rest of the Report refers especially to commerce, administration and war.

SCIENTIFIC INTELLIGENCE.

I. Chemistry and Physics.

1. *On the influence of the direction of transmission upon the passage of radiant heat through crystals.*—Knoblauch has published the second portion of his very elaborate and skillful investigation of this interesting subject. We shall give his results in his own words.

I. Radiant heat penetrates certain crystals of the optically biaxial systems, like Dichroite, Topaz, Diopside, &c., in different quantities in different directions. It passes, for instance, most freely through dichroite in the direction of the middle line, less freely in a direction perpendicular to the plane of the optic axes, and least freely of all in a direction parallel to the supplementary line. In blue topaz, on the contrary, it passes in the smallest proportion in the direction of the middle line, more abundantly perpendicular to the plane of the optic axes and most freely in the direction of the supplementary line. After this transmission the rays of heat, according to their direction within the crystal, exhibit different properties in their behavior for example toward diathermanous bodies. In this particular different crystals exhibit different peculiarities

In the case of polarized heat, differences may appear for one and the same direction according to the position of the plane of polarization. Thus rays of heat whose plane of polarization coincides with the plane of the optic axes penetrate yellow and blue topaz more abundantly parallel to the middle line than those whose plane of polarization is at right angles to the plane of the axes, whereas precisely the contrary is the case in Heavy Spar, Hornblende, Pistacite, Mica, Dichroite, &c.

Rays of heat polarized in different planes often differ from each other in their capacity to penetrate diathermanous bodies after their passage through the crystal. The comparison of the rays polarized in the same sense and transmitted in the same direction exhibits the greatest variety, not only in different crystals but even in those belonging to the same species, as yellow and blue topaz, &c.

In one and the same substance, as for example mica, the quantitative as well as the qualitative differences of the rays polarized in different planes increase with the thickness of the layers penetrated.

When the heat passes successively through two plates of the same crystal, e. g. Pistacite, phenomena are observed analogous to those already mentioned according as the planes of the optic axes coincide or are crossed.

II. When the rays of heat pass through certain crystals of the optically uniaxial systems, as amethyst, idocrase, &c., quantitative as well as qualitative differences are exhibited according as the rays penetrate the crystal in one or another direction.

However great these differences are in the cases of transmission parallel and perpendicular to the axis, no difference of any kind is perceptible in the behavior of rays of heat which, whatever may be their directions, are all transmitted at right angles to the axis.

In this particular, uniaxial differ from biaxial crystals, in which the rays of heat exhibit differences in three directions at right angles to each other.

If the heat is polarized, differences are observed even in the same direction according to the position of the plane of polarization.

Transmissions perpendicular to the axis exhibit however in this case corresponding peculiarities.

It is only when the rays are transmitted along the axis that their passage and quality are independent of the position of the plane of polarization.

The differences in the penetration of the crystal in different directions are greater with polarized than with natural rays, if the plane of polarization be at one time parallel and at another perpendicular to the axis; they vanish however completely when the plane of polarization coincides with the axis. Rays of heat which have passed through amethyst and idocrase differ, under otherwise similar circumstances, with respect to their quantity and their capacity of transmission through diathermanous substances.

All these observations correspond completely with those which the author formerly made with rock crystal, beryl and tourmaline.

III. Even in crystals belonging to the regular system like colored fluor spar, blue streaked rock salt, &c., where, for instance, an arrangement in the form of layers is present, differences in the quantity as well as in the quality of the rays of heat may occur according to the direction in which they are propagated. The same is true for polarized rays. For the same direction the position of the plane of polarization has no influence.—*Pogg. Ann.*, xciii, 161, *Sept.*, 1854.

2. *On the condensation of gases by solid bodies, and on the heat disengaged in the act of absorption.*—Favre has studied the development of heat produced by the absorption of gases by porous solids, and has compared the quantity of heat thus set free with the latent heats of vaporization and liquefaction of the gases in question. The author first determined by means of his mercurial calorimeter the latent heats of protoxyd of nitrogen and of carbonic and sulphurous acids. He employed the same instrument to determine the heat produced by absorption and arrived at the following results. (1.) For the same gas the coefficient of absorption by carbon may vary with the kind of wood charred, and even with different specimens of the same coal. The same specimen of charcoal may present differences at different times. Heavy woods yield charcoals which absorb the least amount of gas. The gases are absorbable in the following order: ammonia, muriatic acid, sulphurous acid, protoxyd of nitrogen, carbonic acid.

(2.) The gases may be classed in the same order relatively to the amount of heat disengaged during the process of absorption to saturation. The comparison is made with equal weights of gas.

(3.) The maximum amount of heat disengaged by the absorption of 1 gramme of sulphurous acid or of protoxyd of nitrogen greatly exceeds the latent heat of liquefaction of equal weights of the same gases. Thus the latent heat of sulphurous acid is 88·3 units, while its heat of absorption is 150·1 units: the latent heat of protoxyd of nitrogen is 100·6 and its heat of absorption 148·3. In the case of carbonic acid

the heat of absorption is greater than the heat of solidification, the former being 148·8 and the latter 138·7 units.

(4.) In the case of certain gases the sum of the heat disengaged, for the same weights of gas absorbed, is the same, whatever be the nature of the carbon, which in this case only affects the volume of the gas fixed in its pores. This result taken in connection with the others seems to shew that the thermic effect is not due to the liquefaction of the gas, but to some special action, since the introduction of a small quantity of gas under conditions in which we cannot suppose it to be liquefied, according to the calculations of Mitscherlich, disengages more heat than the quantity necessary for saturation. It appears possible that this action is due to the special force which Chevreul assumes and calls capillary affinity.—*Comptes Rendus*, xxxix, 929, *Oct.* 16, 1854.

3. *Researches on the Ethers.*—Berthelot has studied the action which acids when confined in close vessels exert upon the compound ethers and upon alcohol and common ether, the actions being assisted by time and by heat. The author classes his results according to three different series of facts.

(1.) Formation of the compound ethers by means of hydric ether and acids.

(2.) Direct formation of the ethers by means of alcohol and acids.

(3.) Decomposition of the ethers under the influence of water and acids.

1. When ether and different acids are heated together in strong closed tubes to a temperature of from 360° to 400° C., water is set free and a compound ether is formed. In this manner the author produced benzoic, palmitic, butyric and chlorhydric ether. When ether, butyric and sulphuric acids are distilled together, butyric ether is formed in abundance, while at the same time olefiant gas is generated. Acetic ether was formed by a precisely similar process. 2. When alcohol is heated in closed tubes with the fatty acids, which as is well known are the feeblest of the organic acids, the corresponding ethers are readily produced, although the combination is never total. In the presence of a strong acid, however, the combination is most abundant. At 100° the author produced in great abundance, after 30 hours of contact, benzoic, acetic and butyric ethers. Stearic ether was formed in very small quantity at the end of two hours, but when acetic acid was added the stearic acid was completely acidified in the same space of time. 3. In the direct formation of the ethers by the processes already indicated, neither the alcohol, ether or acid, even enter completely into combination, whatever be the respective and reciprocal excess of the reacting bodies. Berthelot attributes this with great probability to the decomposing action exerted on the ethers by the water set at liberty in the decomposition itself, the intensity of the action being augmented by the presence of acids. Thus water heated to 100° during 102 hours with stearic and oleic ethers begins to decompose them, regenerating stearic and oleic acids. At 240° and after some hours of contact, water begins to acidify benzoic ether; at the same temperature acetic ether undergoes a similar decomposition. The presence of a free acid increases the effect; thus acetic acid by a contact of six hours at 100° acidifies stearic, butyric and benzoic ethers, producing a sensible pro-

portion of acetic ether. In like manner benzoic acid at 240° produces the decomposition of acetic ether, traces of benzoic ether being formed at the same time. From this it appears that the acid which produces the decomposition may itself enter into combination with the alcohol; the phenomenon is then the replacement of one acid by another. This replacement is particularly well marked with fuming chlorhydric acid. In 106 hours at 100° this body produces the decomposition of acetic, butyric, benzoic and stearic ethers, the acids being set at liberty and chlorid of ethyl formed. The analogy between the double decompositions thus produced and the examples furnished by inorganic chemistry is sufficiently obvious.—*Ann. de Chimie et de Physique*, xli, 432, *August*, 1854.

4. *On the cyanic and cyanuric ethers and on the amids.*—Wurtz has published an elaborate and most interesting memoir on this subject, from which we shall extract those results which appear most striking and important. Cyanic ether brought in contact with water yields carbonic acid and diethyl-urea: the reaction is represented by the equation $2C_6H_5NO_2 + 2HO = C_{10}H_{12}N_2O_2 + 2CO_2$. Water of ammonia dissolves cyanic ether with disengagement of heat and formation of ethyl-urea. Thus $C_6H_5NO_2 + NH_3 = C_6H_8N_2O_2$. The compound ammonias exert a similar action, which the author proposes to consider in a separate memoir. Hydrate of potash and cyanic ether yield carbonate of potash and ethylamin, thus $C_6H_5NO_2 + 2KO, HO = 2KO, CO_2 + C_4H_7N$. Alcohol and cyanic ether yield *ethylurethane*, $C_{10}H_{11}NO_4$, which with caustic potash yields carbonate of potash, ethylamin and alcohol, a decomposition exactly analogous to that of ordinary urethane. With sulphuric acid ethylurethane gives ethylamin and sulphovinic acid: in its pure state it is an oily liquid boiling between 174° and 175° C. Cyanic ether and acetic acid react readily at ordinary temperatures, carbonic acid is disengaged and *ethylacetamid* is formed: the reaction is represented by the equation

$$C_4H_4O_4 + C_6H_5NO_2 = 2CO_2 + N\begin{cases} C_4H_5 \\ C_4H_3O_2. \\ H \end{cases}$$

Caustic potash decomposes ethylacetamid into ethylamin and acetate of potash. It is obvious that ethyl acetamid may be regarded as ammonia in which one equivalent of hydrogen is replaced by one of ethyl and a second equivalent of hydrogen by one of acetoxyl $C_4H_3O_2$. With anhydrous acetic acid, cyanic ether yields *ethyldiacetamid*, $N\begin{cases} C_4H_5 \\ C_4H_3O_2, \\ C_4H_3O_2 \end{cases}$ in which all three equivalents of hydrogen are replaced by other radicals. Formic acid and cyanic ether give carbonic acid and *ethylformiamid*, $N\begin{cases} C_2HO_2 \\ C_4H_5 \\ H \end{cases}$

Wurtz has found in like manner that cyanic ether attacks a great number of acids, the products being amids, the constitution of which may easily be foreseen.

The constitution of cyanuric ether is represented by the formula $C_{16}H_{15}N_3O_3$, or it is isomeric with cyanic ether; it is a colorless crystalline body fusing at 95° C. The author believes that there are how-

ever other cyanuric ethers having a different constitution. Cyanate of methyl is prepared by the distillation of 2 parts of sulphomethylate of potash with 1 part of cyanate of potash. It is a light, colorless, very mobile and volatile liquid, boiling at 40°; its vapors are extremely irritating and suffocating. Its formula is C_2H_3O, CyO, and its most remarkable property is the facility with which it is transformed into cyanurate of methyl, a change which takes place spontaneously when the ether is left to itself in a closed tube. This change sometimes takes place in the course of several days, sometimes in a few minutes, and is accompanied in the last case by a sensible evolution of heat. The cyanurate of methyl is a solid crystalline body, fusing at 175°–176° and boiling at 274°. It is very remarkable that its boiling point is higher than that of the cyanurate of ethyl which is 253°. With caustic potash both these compounds of methyl yield carbonate of potash and methylamin, as the author long since shewed.

Gerhardt and Chiozza have referred the amids which contain oxygen to the type of ammonia, 1, 2 or 3 equivalents of hydrogen being replaced by 1, 2 or 3 equivalents of a radical containing oxygen. Wurtz is of opinion that this view is not applicable to all amids, and especially to those acid amids which are formed by the tribasic acids. He therefore refers these to the type of water, one equivalent of the compound NH being supposed to replace the two equivalents of oxygen in a double molecule of water. Thus the formation of acetamid is represented by the equation $\left.\begin{matrix}C_4H_3O_2\\H\end{matrix}\right\}O_2+NH_2=\left.\begin{matrix}C_4H_3O_2\\H\end{matrix}\right\}NH_2+2HO$. For the further development of this theory we must however refer to the original memoir.—*Ann. de Chimie et de Physique*, xlii, 43, *Sept.* 1854.

5. *On some new Ethers.*—Clermont has studied in Wurtz' laboratory the action of iodid of ethyl upon certain salts of silver, and has obtained several interesting ethers. Iodid of ethyl heated in a closed tube with pyrophosphate of silver yields iodid of silver and pyrophosphate of ethyl. The new ether is a viscid liquid, of a burning taste and peculiar odor, soluble in water, alcohol and ether, and becoming promptly acid on exposure to moist air. Its formula is $PO_5, 2C_4H_5O$. Iodid of ethyl acts in like manner upon tribasic phosphate of silver, producing iodid of silver and the already known tribasic phosphate of ethyl, $PO_5 . 3C_4H_5O$. Carbonic ether may be produced by the action of iodid of ethyl upon carbonate of silver. It is too well known to require description.—*Comptes Rendus*, xxxix.

6. *Action of the protosalts of iron on Nitronaphtalin and Nitrobenzin.*—Under this title Béchamp has published a very interesting and valuable paper on the reducing action of the acetate of protoxyd of iron upon those nitro-compounds in which an equivalent of NO_4 may be considered as replacing an equivalent of hydrogen. The author sets out from his already published observation that ordinary cotton may be reproduced from gun cotton by means of the acetate of iron. He then shews that the acetate exerts a similar action upon nitro-benzin and nitro-naphtalin, and that the products of this reaction are anilin and naphtalidin. The following processes answer for the production of these two bases in large quantities and with the greatest facility, (we

select from various methods given by the author those which he found most advantageous). For the preparation of anilin, 1 part of nitrobenzin, 1·2 parts of iron filings free from rust, and 1 part of concentrated commercial acetic acid are introduced into a capacious retort. The acetic acid must be free from mineral acid and its quantity must be sufficient to completely cover the iron. The action quickly begins without heat and becomes so violent that the liquid boils and much matter passes into the receiver, which must be well cooled. When the retort has become cool, the contents of the receiver are to be poured into it, and the whole is then to be distilled to dryness. An excess of a concentrated solution of caustic potash is to be added to the distillate; hydrated anilin separates upon the surface in a very nearly pure state. The quantity of anilin obtained by this process is almost $\frac{3}{4}$ of the nitrobenzin employed, and the author states that anilin could be prepared at 20f. the kilogramm. The process for preparing naphtalidin is similar: 1 part of nitro-naphtaline, 1·5 of iron filings, and enough acetic acid to cover the mixture completely, are employed. The action begins on applying a gentle heat so as to fuse the nitro-naphtaline; the fire must then be removed and when the violence of the action has ceased the retort placed in a sand-bath so that the belly shall be completely covered. The acetic acid distills over first; the naphtalidin comes over at 300° and condenses in an oily liquid beneath the acid which protects it from the air. The two are to be separated by a second distillation, and the naphtalidin preserved in a tightly stoppered bottle. It is remarkable that the compounds of protoxyd of iron with strong acids do not decompose the nitro compounds.—*Ann. de Chimie et de Physique*, xlii, 186, *Oct.* 1854. W. G.

7. *Prof. Tyndall on some Peculiarities of the Magnetic Field*, (Proc. Brit. Assoc., 1854, Ath., No. 1405.)—The Professor said, a piece of soft iron suspended between the flat poles of an electro-magnet set its largest dimension from pole, the residual magnetism of the cores being sufficient to produce the effect. This is the normal deportment of magnetic bodies, but it is by no means universal. By mechanical agency, by pressure for example, the structure of a magnetic body can be so modified that its shortest horizontal dimension sets from pole. Prof. Tyndall exhibited actions of the kind where the body operated on was compressed magnetic dust. In such a body two opposing tendencies were at work,—the tendency due to length, which sought to set the length axial, and the tendency due to structure, which sought to set the line perpendicular to the length axial. Between the flat poles the latter tendency was predominant, but between pointed poles this was not the case; here the attraction of the ends of the magnetic mass constituted a mechanical couple of sufficient strength to overcome the directive tendency which was due to structure, and to draw the mass into the axial line. But in raising or lowering the body operated on out of the sphere of this local attraction, by bringing it into a position where the distribution of the magnetic field resembled that existing between the flat poles, the body forsook the axial position and turned into the equatorial. The complementary phenomena were exhibited by bismuth. A normal bar of this substance sets its length at right angles to the line

from the poles; but Prof. Tyndall exhibited a bar of this substance, which set between the flat poles exactly as a magnetic body. Such a bar, however, between the points are equatorial. On raising or lowering it, however, it forsook the equatorial position and set axial. In this case the local repulsion of the ends between the points caused the bar to set equatorial, the influence of length thus predominating over the influence of structure; but removed from the sphere of this local action, the directive tendency of the mass triumphed and caused the bar to set axial. The bar in this case was cut with its length at right angles to the planes of most eminent cleavage of the bismuth:—it is a proved fact, that these planes while the influence of form is annulled, always set at right angles to the line piercing the poles, and hence where they are transverse to the length, the bar will set axial. These phenomena were examined in a great number of cases; bars were taken from substances possessing a directive tendency, and it was so arranged that the directive tendency due to structure was always opposed to the influence of length; between the points the former tendency succumbed to the latter, while between the flat poles, or above and below the points, the former was triumphant. It is amusing to observe the strife of these two tendencies in substances possessing a strong directive action. A plate of crystallized carbonate of iron, when properly suspended, will wrench itself spasmodically from one position into the other, and find rest nowhere. The simple law which governs all these actions is, that if the body, cut as above, be diamagnetic, its length sets equatorial between the points, but above and below them axial. If the body be magnetic it sets axial between the points, above and below equatorial. Hence the rotation of a magnetic body, on being removed from between the points, is always from axial to equatorial; while the corresponding rotation of a diamagnetic body is always from the equatorial to the axial. The deportment of wood in the magnetic field was next described. Nearly sixty specimens examined by Prof. Tyndall were all diamagnetic; each of them was repelled by the poles of the magnet; cubes of each when suspended with the fibre horizontal set between the excited poles, the fibre perpendicular to the line which unites the poles. Thinking that wood on account of its structure, would exhibit those directive phenomena which had been demonstrated in the case of the bodies mentioned at the commencement, bars were taken from nearly forty kinds of wood, the fibre being at right angles to the length of the bar; in the centre of the space, between two flat poles, all those bars set their length from pole to pole. But Prof. Tyndall afterwards observed the remarkable fact, that homogeneous diamagnetic bodies did the same. Bars of sulphur, of salt of hartshorn, of wax, and other diamagnetic substances, when suspended in the centre of the space between two flat poles, set their length from pole to pole. Now, as diamagnetic bodies always take up the position of weakest force, it was proved by these experiments, and corroborated by others not cited here, that the true force of the centres of two flat poles, contrary to the general opinion hitherto received, was the line of minimum force.

The Rev. Dr. Scoresby stated, that, by subjecting to force ordinary magnets of hardened steel, as by suddenly bending them, or striking

them in particular modes, they may have their poles reversed or be deprived of their magnetism, or hardened non-magnetic steel may be instantly rendered magnetic; and he considered that these facts, which he had long since made public, should be kept before the mind in such investigations as the very original and interesting facts just brought under the notice of the Section.—Prof. FARADAY after very briefly, yet lucidly, explaining to the Section the leading distinctions between paramagnetic and diamagnetic bodies, and their behavior in the magnetic field, said, that it was conceded on all hands that the explanation was erroneous which Plücker had given of the phenomena which he first discovered connected with the branch of research to which Prof. Tyndall had just been directing their attention, and which he was so ably hunting down. But when he said the original explanation of Plücker was erroneous, he did not mean that as the slightest disparagement to that philosopher. It was well understood by all who had any pretensions to scientific knowledge since the days of Bacon, that it was through the mist of error that the most important discoveries had to be made, and that in pursuing any research it was much better in the first stages of the inquiry to have erroneous views, than to be without any views that would tend to connect the scattered facts. For his part, he was not ashamed to own that he was a learner, and that in almost every instance it was through the clouds of error that he arrived at the conclusions which satisfied him most. And as his mathematical skill and acquirements were by no means such as to entitle him to despise instruction, he should feel particularly grateful to his mathematical friends present, Dr. Whewell and others, if they would explain to him and to the Section the law of distribution of the magnetic force in the magnetic field, if it was known.—Dr. WHEWELL explained how the force would be distributed upon the old theory of magnetic lines; but he said he was aware, and he believed it was now generally admitted, that this theory must be greatly modified, if not given entirely up. But as he saw Prof. W. Thomson in the Section, who had paid particular attention to the development of the mathematical theory of magnetical and electrical forces, he trusted that that gentleman would favor the Section with his views.—In answer to Prof. Faraday's question, as to the mathematical conditions under which a uniform field of magnetic force may be produced, Prof. W. THOMSON remarked, that the mathematical theory of the distribution of force afforded both a remarkably simple and definite general answer, and pointed out the most convenient practical means of fulfilling these conditions either approximately or rigorously. For, in the first place, it is strictly demonstrable that if the force be rigorously uniform in some locality, in the neighborhood of any kind of magnet or electro-magnet, through even one one-thousandth of a cubic inch, in fact, through any finite bulk however small, it cannot but be rigorously uniform through every portion of space to which it is possible to go from that locality without passing through the substance of the magnet. Hence, although between flat poles, such as Mr. Faraday first introduced for obtaining uniformity of force, we have in reality a most excellent practical approximation to a uniform distribution of very intense magnetic force, through a space of several cubic inches, in a locality not only visible, but in every way convenient for experi-

mental purposes; yet it is absolutely impossible that the force can be rigorously uniform through the smallest finite bulk of the magnetic field in any such arrangement, or, generally, in any locality external to a magnet. If an experimenter wants a rigorously uniform field of force, he can have it only in the interior of his magnet; and he must be contented not to see the action he experiments on at the time it is being produced, unless he will follow the example of Prof. Faraday, who "went into a hollow cubical conductor of electricity and lived in it," and so was enabled to observe some most interesting and important fundamental properties of electrical force. It would be easy to make a hollow electro-magnet, in the interior of which the experimenter could observe with the minutest accuracy the bearings of all kinds and shapes of bodies in a rigorously uniform field of force. All that is necessary to make such a conductor is to take a hollow papier-mâché globe, say six feet in diameter, and roll a galvanic wire over its surface in a succession of close parallel circles, having their planes at equal distances from one another. A hollow non-magnetic body of any shape, cubical for instance, may have a rigorously uniform distribution of magnetic force produced in its interior by a suitable distribution of galvanic wire over its surface, determinable, according to the form of this surface, by the mathematical theory from which these results are stated. But it would be difficult, perhaps practically impossible, to get a sufficient intensity for exhibiting the forces experienced by diamagnetic or weakly paramagnetic bodies in a uniform field of such extent that the operator could himself enter it; and experimenters must be contented either with approximations to uniformity, such as in the arrangement with flat poles, so successfully used by Prof. Tyndall in the beautiful experiments which he had exhibited to the Section, or they must arrange to test effects in the interior of hollow electro-magnets without seeing them at the time they are taking place. Interesting questions, which the mathematical theory answers decisively, had also been asked regarding the minimum condition of the central line in a field between opposed flat poles, of two cylindrical soft-iron bar magnets, and the effects of rounding off the edges of these poles. It appears that, if we consider the intensity of the force in a plane perpendicular to the magnetic axis through the centre of the field, we find it increasing from the central point to a certain circle of maximum intensity, beyond which it diminishes gradually and falls to nothing at an infinite distance. If the edges of the cylinders be rounded off, the circle of maximum intensity contracts, its centre always being a point of minimum intensity, until a certain degree of convexity of the poles is attained, when the circle of maximum intensity becomes contracted to a point—the central point of the field—which will then be a point of maximum intensity (the central minimum being eliminated), and will continue a maximum, as regards all points in the plane through it, perpendicular to the axis, for any less flat or more prominent or pointed forms of poles. No form of rounded poles, by doing away with maximum or minimum points, can possibly give a uniform distribution of intensity through ever so small a finite bulk of the field.

II. Mineralogy and Geology.

1. *Analysis of Allophane from the Black oxyd of Copper mines of Polk County, Tennessee;* by Dr. C. T. Jackson, Assayer to the State of Massachusetts, &c.—*Description.*—This mineral occurs in the great veins of black oxyd of copper of Polk County, Tennessee, encrusting the black oxyd of copper, and is especially abundant in the mine worked by Mr. Congdon. It occurs in botryoidal and reniform concretions with a crystalline aspect somewhat resembling concretions of Prehnite in appearance.

Its color is honey yellow. Lustre resinous, particularly on fractured surfaces. It is brittle and is easily crushed to powder in an agate mortar. In a glass tube it gives off much water when heated, and the mineral becomes opaque, and is then very friable.

Before the blowpipe on charcoal becomes white and opaque, but does not melt. With soda it forms a white enamel, and effervesces in fusing. With borax forms a clear transparent glass. With salt of phosphorus it leaves a skeleton of silica of large size in the glass, but gives no color. Pulverized and placed in warm hydrochloric acid it gelatinizes readily and decomposes, leaving flakes of silica. By qualitative analysis the mineral is found to contain silica, alumina, lime, magnesia and phosphoric acid.

Quantitative analysis on 2 grammes of the mineral.—One gramme of the mineral heated to full redness in a platinum crucible, loses 0·377 gramme of water.

One gramme of the mineral that had not been ignited was decomposed by chlorohydric acid in a platinum crucible, and then the usual process of analysis for the separation of the different ingredients was pursued, and the following results were obtained:

Water,	0·377
Alumina,	0·410
Silica,	0·198
Lime,	0·005
Magnesia,	0·002
Phosphoric acid,	*traces*
	0·992

The presence of phosphoric acid was proved on the gramme of the mineral that had been ignited by digesting the mineral in chlorohydric acid, evaporating to dryness, and then dissolving in water with a little chlorohydric acid, and filtering and adding to the filtrate nitric acid, and ammonia not quite sufficient to saturate the acids, and then adding a clear solution of molybdate of ammonia. A fine yellow powder forms and subsides in the warm solution—showing the presence of phosphoric acid.

2. *On the Boracic Acid Compounds of the Tuscan Lagoons;* by Emil Bechi, (Berg- und hüttenmännische Zeitung, Oct. 18, 1854.)—Since the publication in the American Journal of Science of descriptions and analyses of some Tuscan minerals containing boracic acid, which had been described and analyzed by Prof. Meneghini and myself (as communicated to Prof. Dana by Prof. Meneghini), I have further investigated the subject with some new results interesting to mineralogical

science and illustrating the products of Tuscany. It is known that at certain places between Volterra and Siena there are springs or lagoons of hot water issuing from natural or artificially made craters, which contain a large proportion of boracic acid compounds. These Soffioni or Bulikamen, as the exhalations are called, sometimes change their place of opening, making another at some point of easier outbreak. The rock about some of the older openings has often undergone alteration and sometimes is covered with peculiar concretions. A specimen of this kind from an old lagoon of the proprietor Larderell was observed by Professor Savi and is now in the Museum at Pisa. It affords on different parts three distinct mineral species. One of them is a borate of soda, and has the following constitution:

Boracic acid.	Soda.	Water.	Lime & Magnesia.	
43·559	19·254	37·187	*trace*	$= \dot{N}a\,\ddot{B}^3 + 6\dot{H}$

The formula differs from that of borax, in having $6\dot{H}$ in place of $10\dot{H}$.

The second species is borate of lime, which afforded me

Bor. acid.	Lime.	Water.	$\ddot{S}i, \ddot{A}l, \dot{N}a$	$\dot{M}g$	
51·135	20·850	26·250	1·750	*trace*	$= \dot{C}a\,\ddot{B}^3 + 4\dot{H}$

It is probably hydroborocalcite, which differs only in containing $6\dot{H}$.

These boracic acid compounds, the borate of soda and hydroborocalcite, are very similar in physical characters and chemical relations, and may be varieties of the same species.

The third species, finally, afforded by the above mentioned specimen, has an ochre-yellow color and is crystalline. Heated it loses water and becomes black. B.B. fuses with difficulty. In chemical characters, it is a borate of iron mixed with hydroborocalcite and hydroboracite.

The existence of borate of iron in concretions at the Tuscan lagoons was remarked by Beudant in 1832. Both Dufrenoy and Dana, in their mineralogical works have mentioned these concretions under the name Lagonite, without giving an analysis or formula.

In the collections of Tuscan minerals of John Targioni, I detected an ochre-yellow mineral, which gave the tests of the iron borate; and afforded on analysis—

Boracic acid.	Sesquioxyd of iron.	Water.	$\ddot{S}i, \ddot{A}l, \dot{C}a, \dot{M}g$
47·955	36·260	14·016	1·769

The Lagonite therefore is no longer a hypothetical species, but one well characterised, and having the composition $\ddot{F}e\,\ddot{B}^3 + 3\dot{H}$.

Sometime since Signor Larderell in an old lagoon, found a druse which was peculiar in its physical and chemical characters. The mineral was in yellowish-white rhombic tables of 110° 6′, and by polarised light showed a resemblance to sulphate of lime. On heating in a glass tube, a strong ammoniacal odor is given off: B.B. fuses easily to a colorless glass, which on treating with alcohol, gives a green color to the flame.

From these characters I concluded that it was a borate of ammonia, a species hitherto unnoticed, except that Erdmann in the analysis of Sassolin has reported the presence of some ammonia. Careful analysis afforded me—

Boracic acid.	Oxyd of ammonium.	Water.	
69·244	12·897	17·859	$= N\,HO^4\,\ddot{B}^4 + 4\dot{H}$

This species I have named *Larderellite*, after Sr. Larderell.* On boiling the Larderellite in water, ammonia is given out, and a new crystalline salt is obtained, having the formula $N HO^4 \dot{B}^6 + 9\dot{H}$. Berzelius obtained by neutralizing boracic acid and ammonia, a salt crystallizing in hexagonal prisms containing according to Gmelin $N HO^4 \dot{B}^4 + 6\dot{H}$. It differs from the Larderellite in composition and strikingly in crystalline form. It appears that one and the same salt may be obtained, with different proportions of water, by employing different temperatures; and thus is easily explained the analogy between the *borate of soda* of the lagoons and *borax*, the borate of lime and hydroborocalcite, the Larderellite and Berzelius's borate of ammonia. In the same way according to Berzelius, the sulphate of the protoxyd of manganese crystallized at the temperature of 6° R., gives the formula $\dot{Mn}\dot{S} + 7\dot{H}$, but between 6° and 20°, the formula $\dot{Mn}\dot{S} + 6\dot{H}$; and between 20° and and 30°, $\dot{Mn}\dot{S} + 4\dot{H}$. The interesting point in this subject is that these compounds of manganese differ widely and irreconcilably in crystallisation, showing the influence of the water of crystallisation on the crystalline form.

Laurent takes boracic acid for monobasic—as the borate of oxyd of methyl $= C^2H^3O, BO^3 + HO, BO^3$; and the borate of oxyd of æthyl $= C^4H^5O, BO^3 + HO, BO^3$; and borax for a neutral salt, in which 1 equivalent of base is replaced by 1 of water, whence the formula of borax is

$$Na\,O, HO, 2BO^3 + 9HO \quad \text{or} \quad 2((\dot{Na}, \dot{H})\dot{B}) + 9\dot{H}.$$

This view is sustained by many examples among other boracic acid compounds, which are described in Wöhler and Liebig's Annalen. Following Laurent's theory my formulas become, for the

Borate of lime,	$(\dot{Ca}, \dot{H})\dot{B} + 3\dot{H}$
Borate of soda,	$(\dot{Na}, \dot{H})\dot{B} + 5\dot{H}$
Larderellite,	$(N HO^4 + \dot{H})\dot{B} + \dot{H}$

[The author closes with some observations on the condition of the boracic acid of the lagoons.]

3. *On the Thickness of the Ice of the Ancient Glaciers of North Wales, and other Points bearing on the Glaciation of the Country;* by Prof. Ramsay, (Proc. Brit. Assoc., Athen., No. 1405.)—Prof. Ramsay stated his belief that there had been two sets of glaciers in North Wales since the ground assumed its present general form. The first was on a very large scale, followed by a slow subsidence of the whole country to the extent of 2,300 feet, until only the tops of the highest hills remained uncovered by the sea; and when the mountains again rose, a set of smaller glaciers was formed. The thickness of the ice in existing Swiss glaciers was known to be very great; in the Grindelwald it had been ascertained to amount to 700 feet, and in other instances was probably thicker. The observations of Agassiz and Prof. James Forbes on the height to which grooved and polished surfaces span up the sides of Alpine valleys, had led to the conclusion, that the ice had once been much more extensive; and that in the glacier of the Aar, for example, it must have amounted to 2,000 feet. The same

* Another hydrous compound of boracic acid and ammonia I have since noticed which will hereafter be described.

method of observation had been applied to North Wales; and it had been ascertained that in the Pass of Llanberris the grooves and roundings of the rocks extended to a height of 1,300 feet above the present bottom of the valley. The drifted deposits which overlie these rounded surfaces must have formed during the slow depression which followed, and the glaciers must still have existed, since these deposits, though marine, are still of a moraine character. The cold climate continued during the period of depression, and for some time after it; and there was beautiful evidence in the side valleys of the gradual decrease of the glaciers until they died away amongst the higher mountains, in the form of moraines stretching across the valleys, one within the other. The scratches made by the first set of glaciers passed down the valleys; those of the smaller glaciers crossed the first obliquely.

4. *On the Foliation of some Metamorphic Rocks in Scotland;* by Prof. E. Forbes, (Ibid.)—It was of great importance to geologists to distinguish between lamination, cleavage, and foliation: the first resulted from original planes of deposition: the second was a superinduced structure, dividing rocks into laminæ of similar constitution, not coincident with the lines of bedding; thirdly, foliation was the division of a rock into laminæ of different mineral condition. Cleavage had been attributed, by Prof. Sedgwick, its first definer, to electrical action; by Mr. Sorby, to a mechanical force; and by Mr. D. Sharpe, to mechanical and chemical influence. The foliation of mica slate, or separation of its mineral constituents into distinct layers, had been sometimes attributed to metamorphic action on layers of different constitution; Mr. Darwin had considered it identical with cleavage, and due to the same cause,—the one passing into the other: the same view has been maintained by Mr. Sharpe. Prof. Forbes agreed with those who considered it a superinduced structure quite distinct from cleavage or lamination. The author then referred to examples of foliated structure. In a roadside quarry at Crianlarich, near the head of Loch Lomond, where the metamorphic limestone is not distorted, and exhibits distinct lines of bedding, of a pale blue color, caused by the presence of iron; also lines of different mineral matter, the laminæ frequently curved round nuclei; and dark lines of crystals of calcareous spar, produced, perhaps, by the metamorphism of bands of fossils. In the upper part of the quarry the limestone becomes foliated with mica,—the foliation being at first parallel with the bedding, then becomes wavy and contorted, is affected by small faults, and contains nuclei of calcareous spar and at length passes into a mica slate. At Ben Os there is a calciferous band in the mica slate, which, having the same strike with the Crianlarich beds, may eventually prove a guide in unravelling the structure of the country. Two miles from Inverarnon there is a bed of porphyritic trap in mica slate, and the foliation on the sides of the trap is conformable. Four miles from Inverarnon, in a quarry of trap, which sends large and small veins into the mica slate, there is evidence of a second foliation having taken place, following the small veins of trap. Near Tarbert, the mica slate is foliated and contorted; and a bed of calcareous grit cuts through it, without disturbing the relations of the curves and laminæ. In a slate quarry at Luss, the foliation accords in the main with cleavage, as observed by Mr. Sharpe, in the corresponding district; but whilst the foliation curves round the nuclei of quartz, the cleavage abuts against them.

Foliation has also been noticed in the baked rocks of Salisbury Crags. Prof. Forbes concluded, 1, that foliation was a superinduced structure; 2, that it was distinct from cleavage; 3, that it was not of mechanical origin, but a chemical phenomenon; 4, that it was, perhaps, induced by more than one agency.

5. *On the Relations of the "New Red Sandstone" of the Connecticut Valley and the Coal-bearing rocks of Eastern Virginia and North Carolina;* by Prof. W. B. ROGERS, (Proc. Boston Soc. Nat. Hist., 1854, p. 14.)—Prof. W. B. Rogers exhibited a series of fossils from the middle secondary belts of North Carolina, Virginia, Pennsylvania, and Massachusetts; chiefly, he said, with the view of calling attention to the evidence afforded by some of them, of the close relation in geological age between what has been called the New Red Sandstone of the Middle States and Connecticut Valley, first designated by Prof. H. D. Rogers as the Middle Secondary Group, and the coal-bearing rocks of Eastern Virginia and North Carolina.

Prof. Rogers referred to the existence in Virginia of three distinct belts of these rocks. The most eastern of these, extending almost continuously from the Appomatox River to the Potomac, includes the coal-fields of Chesterfield and Henrico Counties. The middle tract, about twenty-five miles west by south of the preceding, is of much less extent, and has not yet furnished any workable coal seam. Somewhat intermediate in trend to these is a belt of analogous rocks in North Carolina, commencing some distance south of the Virginia line and stretching southwestwardly across the State, and for a few miles beyond its limits, into South Carolina. This area, first mapped by Prof. Mitchell, includes the coal-bearing rocks of Deep River. The western belt extends, with two considerable interruptions, entirely across Virginia, being prolonged towards the southwest in the course of the Dan River in North Carolina, and towards the northeast through Maryland, Pennsylvania, and New Jersey, forming what is usually called the New Red Sandstone Belt.

Eastern and Middle Belt of Virginia and Eastern Belt of North Carolina.—From an examination some twelve years ago of the fossil plants of the most eastern of the Virginia belts here designated, Prof. Rogers had been led to refer this group of rocks to the Oölite series on or near the horizon of the carbonaceous deposits of Whitby and Scarborough in Yorkshire. Some years later he discovered many of the same plants in the middle belt of Virginia, and, in the summer of 1850, he found several of these plants in the coal rocks of Deep River, in North Carolina. In each of the latter districts we meet with Equisetum columnare, Zamites, and a plumose plant referred to Lycopodites, and strongly resembling *L. Williamsonis* of the Yorkshire rocks. These are among the usual forms occurring in the easternmost of the Virginia belts.

Besides the fossil plants common to these three areas, they contain two species of Posidonomya and two of Cypris. Of the Cypridæ, one species has a smooth, the other a beautifully granulated carapace. They are both very small, seldom exceeding $\frac{1}{30}$ an inch in length and $\frac{1}{70}$ in width. Both species of Posidonomya differ in proportion from

the *P. minuta* of the European Trias, but one of them strongly resembles the *P. Bronnii* of the Lias, although of larger dimensions.

Prof. Rogers remarked upon the uncertainty which exists as to the true nature of the small shell-like fossils, which being assumed as molluscs, have been referred to Bronn's genus Posidonomya. But, whatever may be their zoölogical affinities, the fossils now under consideration have great interest, as affording further means not only of comparing together the mesozoic belts of North Carolina and Virginia, above referred to, but of approximating more justly than heretofore to the age of the so-called New Red Sandstone, or Triassic rocks which form the prolonged belt lying further towards the west.

In the report of Prof. Emmons, published in the autumn of 1852, mention is made of the remains of Saurians in the Deep River deposits, as well as of the Posidonia and Cypris, and of an Equisetites, a Lycopodites and other allied forms, together with a naked, rather spinous vegetable, regarded by him as a cellular cryptogamous plant.

In view of the general identity of the fossils thus far found in the Dry River and Middle Virginia belts, with those of the most eastern deposit in Virginia, viz., that including the coal of Chesterfield, Prof. Rogers maintained that the general equivalency of these three areas may be regarded as established, and therefore the Dry River belt of North Carolina, as well as the Middle Virginia belt, ought to be placed in the Jurasic series, not far probably above its base.

Western Belt of North Carolina and Virginia and its Extension towards the Northeast, forming the so-called New Red Sandstone of Virginia, Pennsylvania and New Jersey, and probably of the Valley of the Connecticut.—In North Carolina, on the Dan River, where the rocks include one or more thin seams of coal, the same Cypridæ or Posidoniæ are found in great numbers in some of the fine-grained shales and black fossil slates. The latter were noticed as early as 1839, by Dr. G. W. Boyd, while on the Virginia Geological Survey. Regarding this fossil, of which specimens were also obtained about the same time from the middle belt in Virginia, as identical with the Posidonia of the Keuper, Prof. Rogers had, many years ago, announced the probability that a part or all of the great western belt was of the age of the Trias, instead of being lower in the Mesozoic series.

Specimens of the Posidoniæ and Cypridæ, from both belts in North Carolina, and from the eastern and middle belts in Virginia, were exhibited by Prof. Rogers at the Albany meeting of the American Association of Science, in 1851, for the purpose of showing the close relationship between these deposits, in geological time. Among the specimens from the Dan River, Prof. Rogers on the present occasion referred to the impression of a Zamite leaf and a joint of Equisetum columnare. Prof. Emmons, in the report above referred to, speaking of the marly slate of this system, says that "it differs in no respect from that of Deep River, bearing the same fossils, Posidonia and Cypris, in great abundance."

In the belt in Virginia, toward the Potomac river, Prof. Rogers had lately found immense numbers of the same Posidonia and Cypridæ, crowded together in fine argillaceous shales, and at several points he had met, in the more sandy rocks, vegetable impressions, which, although obscure, are strongly suggestive of the leaves of Zamites.

In the same belt in Pennsylvania, in the vicinity of Phœnixville, early last spring, Prof. H. D. Rogers discovered Posidoniæ in great numbers in a fissile black slate, and on subsequent examination, the same beds were found to contain layers crowded with the casts of Cypridæ. Along with these are multitudes of Coprolites, apparently Saurian, resembling in size and form the Coprolites found in the carbonaceous beds on Deep River, and also some imperfect impressions of Zamites leaves. These facts Prof. Rogers considers sufficient to identify, as one formation, the disconnected tracts of this belt in North Carolina and Virginia, and the great, prolonged area of the so-called New Red Sandstone of Maryland, Pennsylvania, and New Jersey.

As to the geological date of this belt, Prof. Rogers said that the discovery at various and remote points of its course of Posidoniæ, Cypridæ, and Zamites, most or all of which are identical with these forms in the eastern middle secondary areas of Virginia and North Carolina, makes it extremely probable that these rocks, formerly referred to the New Red Sandstone, and of late more specially to the Trias, are of Jurassic date, and but little anterior to that of the Coal Rocks of Eastern Virginia.

Prof. Rogers considered the frequent occurrence of Cypridæ in all these belts as a strong evidence of their Jurassic age. While only a few species of Cypridæ, and many of the allied genus Cytherina occur in the Silurian and Carboniferous rocks, there is a total absence of these crustacean remains throughout the series of deposits extending from the base of the Permian to the lower limits of the Oölite. But on entering the latter, the Cypridæ re-appear, and become very abundant there, there being no less than twelve species known to belong to the Oölite formations of Europe.

On comparing the silicified wood, found in the western and eastern belts, Prof. Rogers had found its structure to be the same, and to agree very nearly with the fossils figured by Witham under the name of Peuce Huttonia. As this particular structure does not appear to have been met with below the Lias, and occurs in that formation, it furnishes another argument in favor of the Jurassic age of all these rocks.

Prof. Rogers added, that he had not found in the New Red Sandstone of the Connecticut Valley either the Posidonia or Cypris, although he had met with obscure markings which he was inclined to refer to the latter. He had however satisfied himself that one of the plants, from the vicinity of Greenfield, in Massachusetts, was identical with the form in the Virginia coal rocks referred to Lycopodites, and probably *L. Williamsonis;* and that among the other very imperfect impressions associated with this, was one which he regarded as the leaf of a Zamites.

On the whole, therefore, Prof. Rogers concluded that the additional fossils from the coal-bearing rocks of Virginia and North Carolina served to confirm the conclusion of their being of Jurassic date, and that the fossils, thus far found in the more western belt, and its extension through Pennsylvania and New Jersey, rendered it proper to remove it from the Trias and place it also in the Jurassic period, a little lower probably than the eastern belt of North Carolina and Virginia; and there could be little doubt, he thought, that the same conclusion would apply to the New Red Sandstone of the Connecticut Valley.

6. *Note on an indication of depth of Primeval Seas, afforded by the remains of color in Fossil Testacea;* by EDWARD FORBES, F.R.S., Pres. G. S., (Proc. Roy. Soc., March, 1854.)—When engaged in the investigation of the bathymetrical distribution of existing mollusks, the author found that not only did the color of their shells cease to be strongly marked at considerable depths, but also that well-defined patterns were, with very few and slight exceptions, presented only by testacea inhabiting the littoral, circumlittoral and median zones. In the Mediterranean only one in eighteen of the shells taken from below 100 fathoms exhibited any markings of color, and even the few that did so, were questionable inhabitants of those depths. Between 35 and 55 fathoms, the proportion of marked to plain shells was rather less than one in three, and between the sea-margin and 2 fathoms the striped or mottled species exceeded one-half of the total number.

In our own seas the author observes that testacea taken from below 100 fathoms, even when they were individuals of species vividly striped or banded in shallower zones, are quite white or colorless. Between 60 and 80 fathoms, striping and banding are rarely presented by our shells, especially in the northern provinces; and from 50 fathoms shallow-wards, colors and patterns are well marked.

The relation of these arrangements of color to the degrees of light penetrating the different zones of depth, is a subject well worthy of minute inquiry, and has not yet been investigated by natural philosophers.

The purpose in this brief notice is not, however, to pursue this kind of research, but to put on record an application of our knowledge of the fact that vivid patterns are not presented by testacea living below certain depths, to the indication of the depth, within certain limits, of palæozoic seas, through an examination of the traces of color afforded by fossil remains of testacea.

Although their original color is very rarely exhibited by fossil shells, occasionally we meet with specimens, in which, owing probably to organic differences in the minute structure of the colored and colorless portions of the shell, the pattern of the original painting is clearly distinguished from the ground tint. Not a few examples are found in mesozoic as well as in tertiary strata, but in all the instances on record, the association of species, mostly closely allied to existing types, and the habits of the animals of the genera to which they belong, are such as to prevent our having much difficulty about ascertaining the probable bathymetrical zone of the sea in which they lived.

But in palæozoic strata the general assemblage of articulate, molluscan and radiate forms is so different from any now existing with which we can compare it, and so few species of generic types still remaining are presented for our guidance, that in many instances we can scarcely venture to infer with safety the original bathymetrical zone of a deposit from its fossil contents. Consequently any fact that will help us in elucidating this point becomes of considerable importance.

Traces of coloring are rarely presented by palæozoic fossils, and the author knows of few examples in which they have been noticed. Professor Phillips, in his 'Geology of Yorkshire,' represents the carboniferous species, *Pleurotomaria flammigera* (i. e. *carinata*) and *conica*, as

marked with color, and Sowerby has figured such markings in *P. carinata* and *P. rotundata*. In the excellent monograph of the carboniferous fossils of Belgium, by Professor De Koninck of Liège, indications of pattern-coloring are faintly shown in the figures of *Solarium pentangulatum*, and distinctly in those of *Pleurotomaria carinata* and *Patella solaris*.

In the cabinets of the Geological Survey of Great Britain are some finely-preserved fossils from the carboniferous limestone of Parkhill, near Longnor in Derbyshire. Among these are several that present unmistakable pattern-markings, evidently derived from the original coloring. They are—

Pleurotomaria carinata and *conica*, showing wavy blotches, resembling the coloring of many recent *Trochidæ*.

An undescribed *Trochus*, showing a spiral band of color.

Metoptoma pileus, and

Patella? retrorsa, both with radiating stripes, such as are presented by numerous existing *Patellidæ*.

Natica plicistria, with broad mottled bands.

Aviculo-pecten, a large unnamed species, with spotty markings on the ribs in the manner of many existing *Pectines*.

Aviculo-pecten sublobatus, Ph.? Beautifully marked with radiating, well-defined stripes, varying in each individual, and resembling the patterns presented by those recent *Aviculæ* that inhabit shallows and moderate depths.

Aviculo-pecten intercostatus and *elongatus* also exhibit markings.

Spirifer decorus and *Orthis resupinata*, show fine radiating white lines.

Terebratula hastata, with radiating stripes.

The analogy of any existing forms that can be compared with those enumerated, would lead to the conclusion that the markings in these instances are characteristic of mollusks living in less depth of water than 50 fathoms. In the case of the *Terebratula*, which belongs to a genus the majority of whose living representatives inhabit deep water, it may be noticed that all the living species exhibiting striped shells are exceptions to the rule, and come from shallow water.

There are many circumstances which warrant us to suspect that the carboniferous mountain limestone of most regions was a deposit in shallow water. The facts now adduced materially strengthen this inference.

In the British Museum there is a beautifully spotted example of a Devonian *Terebratula*, brought by Sir John Richardson from Boreal America.

Specimens of the *Turbo rupestris*, from the Lower Silurian Limestone of the Chair of Kildare near Dublin, exhibit appearances that seem to indicate spiral bands of color.

7. *Arsenate of Lead and Vanadate of Lead.*—Beautiful specimens of these two minerals have been detected by Dr. J. Lawrence Smith among the minerals coming from the Wheatley Mine near Phœnixville, Penn. A full description of them will be given in his next paper on the reëxamination of American minerals.

8. *On the Identity of Ripidolite of von Kobell with Clinochlore;* by N. von Kokscharov.—M. N. von Kokscharov has sent us an elaborate paper on the Clinochlore of Achmatowsk and its identity with Ripidolite, which is crowded out of this number and will appear in our next.

III. Botany and Zoology.

1. *Martius, Flora Brasiliensis:* fasc. XII. Dec., 1853. (folio.)—This part of Professor Martius's elaborate Flora of Brazil, which has been long in reaching us, comprises the *Urticineæ*, which are elaborated by Prof. Miquel of Amsterdam, who had already published an excellent and much-needed monograph of the Fig tribe. We are pleased to see that a botanist so thoroughly acquainted with Urticineous plants, and of such sound judgment, does not regard them as a group of orders, but as constituting one large and polymorphous order; the *Urticineæ* in his view being even more extensive than the *Urticeæ* of Jussieu, inasmuch as he takes in the *Ulmeæ* also. Different as the types of the several included groups are, yet they are so intimately connected by every kind of intermediate form that, in Prof. Miquel's opinion, they are not to be definitely separated. His *Urticineæ* accordingly embrace four suborders, viz,—the *Artocarpeæ* (including *Moreæ*), the *Ulmaceæ*, the *Urticeæ*, and the *Cannabineæ*. All but the last of these are of course represented in the Brazilian flora; the *Artocarpeæ* by 16 genera and a large number of species; the *Ulmaceæ* by *Celtis* and *Sponia;* and the *Urticineæ* by 6 genera. The descriptions are illustrated by 45 elaborate folio plates. A. G.

2. *The non-assimilation of Nitrogen by Plants.*—M. Boussingault has published, in the *Annales des Sciences Naturelles*, 4th ser., tom. i, No. 4 and 5, the details of an interesting and well-devised investigation upon the vegetation of several plants, of different families, from which ammonia and all azotized organic matter were excluded; and he finds that under these conditions there is no more nitrogen in the resulting vegetation than there was in the seed, but usually a considerable loss of this element; showing that the nitrogen of the atmosphere is not assimilated by plants in such cases. Another memoir is promised illustrating the conditions under which this element is assimilated when plants are grown in a sterile soil in the open air. A. G.

3. *Lupulin.*—The corpuscles on the bracts and ovaries of the Hop, to which hops owe their essential qualities, have lately been studied, both structurally and chemically, by M. Personne. Their development is explained in the Ann. Sci. Nat., ser. 4, tom. i, No. 5, and illustrated by fine figures drawn by M. Trécul. The corpuscles are of the nature of epidermal glands, of a cup-shaped or saucer-shaped form, the cells of which secrete a yellow liquid, which at length distends the gland, and elevates the cuticle of the upper surface into a form resembling the acorn surrounded below by its cup. The account of these corpuscles given by Raspail appears to have little more foundation in fact than his hypothesis that they are analogous to pollen. A. G.

4. *The Fertilization of Ferns.*—The most important fact in respect to the fertilization of the higher Cryptogamia, which has been brought to light since the publication of Mr. Henfrey's Report on the subject, (reproduced in this Journal, vol. xiv,) has just been furnished by Hofmeister. Suminski, indeed, who discovered the two kinds of organs on the prothallia, or seed-leaves of germinating Ferns, affirmed that he had seen the moving spiral filaments, or spermatozoids, of the anthe-

ridia enter the canal of the archegonia (called by him ovules); but his observations were not thought altogether trustworthy in this and in some other particulars. But Hofmeister, one of the ablest vegetable anatomists, and the most experienced and trustworthy in this kind of investigation, has recently announced (in Proceedings of the Royal Society of Sciences of Saxony, April 22, 1854) that he has seen the moving spermatozoids, not only in the canal of the archegonium of Ferns, but even (in three instances) in the cavity of its central cell, in which the germinal vesicle originates, "actively moving about the germinal vesicle, which is adherent to the vaulted apex of the central cell near the inner extremity of the canal, with its hemispherical free end hanging down in the cavity. In one case where these spermatozoids had arrived at the central cell of an archegonium of *Aspidium Filix-Mas*, the movements lasted for seven minutes from the commencement of the observation. The cessation was accompanied (and probably caused) by the coagulation of the albuminous substance of the fluid contents of the central cell." (Henfrey's transl. in Ann. and Mag. Nat. Hist., No. 82.) In several instances he has seen motionless spermatozoids, lying by the side of the partially developed germinal vesicle. A. G.

5. *Botanical Necrology.*—The year now closing has been a fatal one to an unusual number of scientific men, and especially to botanists. In addition to those mentioned in the last number of this Journal, namely, Dr. Fischer, M. Moricand, and Mr. Webb, we have now to lament the decease of Mr. WINTERBOTTOM and Dr. STOCKS, two English botanists, who had made extensive collections in different parts of India, and had returned home to elaborate their ample materials. Also of G. W. BISCHOFF, Professor of Botany in the University of Heidelberg, a voluminous author, especially of works upon terminology, &c., and an admirable draughtsman. He died of apoplexy on the 11th of September; aged about 60 years. To the list must be added the more celebrated name of M. MIRBEL, one of the most distinguished vegetable anatomists of the age. His earliest publications bear the date of 1801; his latest memoir, on the embryology of Pinus (in which M. Spach was associated with him,) was read before the Academy of Sciences in the autumn of 1843. He shortly afterwards retired from his professorship at the *Jardin des Plantes*, on account of enfeebled health, and has continued with his mind totally prostrated by disease until his death, on the 13th of September. He was one of the luminaries of a past generation. A comparison of his *Traité d'Anatomie et de Physiologie Végétales*, and his *Elèmens de Physiologie Végétales et de Botanique*, with the similar treatises of the present day, will well show the progress that has been made in the science during the first half of the nineteenth century. A. G.

6. *Payer; Traité d'Organogénie Végétale Comparée*, livr. 1–4. Imp. 8vo. Paris: Victor Masson, 1854.—This elaborate work is to form two volumes of letter-press, and an Atlas of 150 plates, of the same imperial 8vo. size. It is issued in monthly numbers, each of about 48 pages of letter-press and 9 or 10 plates. The latter are crowded with admirable details, each having 30 or 40 separate figures. The organogeny of each natural order of plants is treated in succession, and illustrated by details from one or more genera; the figures exhib-

iting the whole development of the principal organs of the blossom, from their earliest appearance to the completed flower-bud. Such investigations are of high importance; although they are not likely to modify very materially views soundly based upon comparison of floral characters. Still they often furnish data for elucidating obscure points of botanical affinity or morphology, or a decisive test of the correctness of an ingenious hypothesis;—data which M. Payer sometimes turns to good account, although he cannot be said thus far to evince any remarkable aptitude for the discussion of such questions. We notice here and there points brought forward as new which have been elsewhere published for some time. A. G.

7. *The Micrographic Dictionary;* by GRIFFITH and HENFREY. (Van Voorst, London.)—Parts III, IV, and V, have reached us since our last notice of this valuable work: the latter ending, on page 128, with the article Ceruminous glands. The articles which strike us as most interesting and important are those upon *Angular aperture*, *Blood*, *Bone* (which is admirably illustrated), and the *Cell*, especially that on the Vegetable cell. A. G.

8. *The Individual in Plants, in its relation to Species*, is the title of a recent Memoir by Professor Braun of Berlin, of so much general interest, and so ably handled, that we hope we may be able to publish a copious abstract of it in a future number of this Journal. A. G.

9. *On the Influence of the Solar Radiations on the Vital Powers of Plants growing under different Atmospheric Conditions;* by J. H. GLADSTONE, (Proc. Brit. Assoc., Athen., No. 1405.)—This was the second Report given by the author under the same title, and commenced by describing accurately what portions of the prismatic spectrum were cut off by the various colored glasses employed in his experiments. A series of observations followed on hyacinths grown under very varied influences of light, and solar heat, and chemical agency. Among the results may be mentioned the power of the yellow ray to diminish the growth of rootlets, and the absorption of water; the power of the red ray to hinder the proper development of the plant; and the effect of total darkness in causing a rapid and abundant growth of thin rootlets, in preventing the formation of the green coloring matter, but not of that of the blue flower, nor of the other constituents of a healthy plant. A series of experiments on germination was then detailed. Wheat and peas had been grown without soil under large colorless, blue, red, yellow, obscured colorless, and obscured yellow glasses, and in perfect darkness. The effects resulting from these varied conditions were very marked; and the description of them occupies a considerable space in the Report. The two plants experimented on—being chosen from the two great botanical divisions—exhibited a wide diversity, sometimes amounting to a direct opposition, in their manner of being affected by the same solar ray; but in the case of both the plants, under the circumstances of the experiment, the following effects were observed:—The cutting off of the chemical ray facilitates the process of germination, and that both in reference to the protrusion of the radicles, and the evolution of the plume: the stem grows unnaturally tall, and there is a poor development of leaves in darkness, becoming more manifest as the darkness is more complete;

and the yellow ray exerts a repellant influence on the roots, giving the wheat a downward and the pea roots a lateral impulse. A few experiments on the germination of other seeds were then narrated; and the Report concluded with an account of experiments on the germination of wheat and peas in oxygen, hydrogen, and carbonic acid gases, as well as in ordinary atmospheric air, and in air from which carbonic acid was at all times certain to be removed. The results confirmed former observations on the necessity of oxygen.

Prof. MILLER, in thanking the author for his valuable researches, made some remarks on the interesting results that the investigation had brought to light; and drew especial attention to the remarkable fact stated in the paper, that the blue rays retarded the action of germination at first, although they probably accelerated the growth of the plant afterwards,—the act of germination being attended with the absorption of oxygen, but the process of development being, on the contrary, attended with the extrication of this gas.—Professor ANDERSON remarked, that a similar difference in the rate of growth of the leguminous plants and grasses to that described by Mr. Gladstone had been observed when they were manured with the same material. Nitrate of soda, which was found to be an excellent fertilizer for grasses, had comparatively little influence upon leguminous plants.

10. *Note on the Mastodon (?), and the Elephas primigenius;* by Sir JOHN RICHARDSON.*—*Mastodon* (?)—At page 102 of the Zoology of the Voyage of H. M. S. Herald, it is stated that the scapula of the Mastodon does not exhibit the remarkable depression which characterises the fragmentary shoulder-bones found at Swan River. Since I have (through the kindness of the author) had an opportunity of consulting Dr. Warren's excellent work on the *Mastodon giganteus*,† I have discovered this assertion to be erroneous; a depression in the same part of the shoulder-blade of that species being noticed in the text by that gentleman, and figured in his large plate. The probability therefore is that the Swan River bones belonged to the *Mastodon giganteus*, and that the range of that species must be extended northwards in Rupert's land to the fifty-second parallel of latitude, while the provisional geographical designation of Elephas Rupertianus must be expunged.

The depression in question was most likely designed to afford a firmer attachment to the central fasciculæ of the *infra spinatus* muscle; and a similar one, though not so sharply defined, exists in the scapula of an Indian fossil elephant from the Seewalik hills, deposited by Dr. Falconer, in the British Museum, as noticed at p. 102; but it is totally wanting in the several scapulæ of the Eschscholtz Bay elephants which are preserved in the British Museum and Haslar Hospital, the part in question being in them smooth and convex.

The error of my former notice above alluded to, arose from an inspection of Mr. Koch's skeleton of the Mastodon now in the British Museum, whose shoulder bones exhibit no such depression. Neither is this character visible in two other scapulæ purchased by the same institution from Mr. Koch as bones of the Mastodon; all the four scapulæ having merely some roughness, but no hollow, in that part of the

* From a communication made by Sir John Richardson to Dr. John C. Warren, from whom the above was received for this Journal.

† Description of the *Mastodon giganteus*, by John C. Warren, M.D., Boston, 1852.

infra spinal surface. From this fact one might be led to conclude that the concavity in question is merely an individual peculiarity, and does not occur generally in the species; but it is rare to meet a mere osteological variety so perfectly alike in form in the two limbs as it is in our Swan River scapulæ, and, as we presume it to be, in both shoulder-blades of Dr. Warren's Newburgh Mastodon; for had it been otherwise, that accurate observer would have mentioned it. And the matter admits of another explanation.

Mr. Koch's skeleton, when first brought from America for exhibition in this country, had its parts not only misplaced, but composed of the bones of more than one individual, there being at least five vertebræ too many in the spine. It may therefore be, that the two scapulæ now forming part of the skeleton of the British Museum Mastodon, and the two detached ones, are in reality bones of the American fossil Elephant, of which a cranium of great size was purchased by the Museum from Mr. Koch. Dr. Warren has shown that the *Mastodon giganteus* and the great fossil Elephant were coeval (op. cit. p. 142); and Mr. Koch may have dug up the remains of both animals from the same deposit. Not the least doubt rests on the authenticity of every part of Dr. Warren's skeleton of the Mastodon,—the account of its discovery and disinterment being quite clear.

The Swan River scapulæ belonged to an individual of intermediate size, between the Cambridge (Mass.) Mastodon and Dr. Warren's.

Elephas Primigenius.—Very recently a fossil skeleton of an Elephant has been discovered by Mr. Roderick Campbell, of the Hudson's Bay Company, on the sixty-first parallel of latitude, on the west side of the Rocky Mountain chain, near the sources of the Yukon or Kwichpack, at an elevation by calculation of considerably more than 1500 feet above the ocean. The skeleton, when first found, was believed to be entire, but unfortunately, the Indians employed to disengage it and bring it home to the Fur Post let it slip into a deep lake, where it now lies, with the exception of a tibia, which was recovered and brought to this country. This bone is of a bluish-white color, has lost some of the rotular surface immediately beneath the knee-joint, and portions of the surface on its rotular and lateral aspects have scaled off; it is otherwise very perfect, the articulating surfaces of the knee and ankle joint being especially in good condition.

On comparing the Yukon fossils with the smaller but more perfect *tibia* brought from Eschscholtz Bay by Captain Beechey, and now in the British Museum,* the popliteal aspects and distal articular surfaces are alike in both, as were also the peroneal and medial aspects; though in this case the comparison is less satisfactory, from the surface having partly scaled off in the Yukon fossil. The circumferences of the proximal articulations are not perfect in either bone, but the parts which remain present no dissimilarities.

Dimensions of tibiæ (by calipers.)

	From Yukon.	Esch. Bay.
Length of the medial face of the shin bone from the brim of the knee-joint to that of the ankle bone, ...	26·1 in.	18·8 in.
Length of the fibular face from the brim of the knee-joint to the proximal edge of the articular surface on which the distal extremity of the fibular moves, ...	23·1 in.	15·8 in.

* Numbered 82–2 and 31A in the Catalogue of the British Museum.

11. *Remains of the Mammoth and Mastodon in California;* by W. P. Blake.—A large tooth of the Elephas primigenius was found about a year since on the shores of the Bay of San Pedro (the sea-port of Los Angelos) California.* It was washed out of a bank by the undermining action of the surf. This bank contains an abundance of shells of species apparently identical with those now living on the coast.

The tooth is in excellent preservation; the grinding surface retaining its polish as perfectly as if it had been but recently taken from the jaw. This grinding surface is five and a half inches long, and exposes the ends of eight plates. The whole length of the tooth is twelve inches.

It is reported that other teeth, together with portions of the skeleton, have recently been found in the earth several miles inland from the Bay, in the direction of Los Angelos.

During my recent visit to the mining region of the State, I ascertained that teeth of both the Elephas primigenius and the Mastodon, had been exhumed at several places from the auriferous flats.

In Calaveras county, at the mining town called Murphy's, several teeth of the Mastodon have been taken out from a depth of about thirty feet below the surface. They were imbedded in blue clay, and associated with auriferous gravel and fragments of talcose slates. Two of the teeth have been preserved, and I was permitted to make drawings of them.

I conversed with a miner at this town, who had found what he supposed was a number of teeth connected together. His partners being anxious to have a specimen to send home, the mass was "split up" and a tooth given to each owner in the claim. This specimen was undoubtedly a tooth of the Mammoth, and the plates were mistaken for single teeth.

A large tusk was taken out of Texas flat about two years ago. It was allowed to remain exposed to the weather outside of a miner's cabin, until it fell to pieces and crumbled away. Many interesting specimens share a similar fate; or they are hoarded up by persons who fancy they have an extraordinary value, and who will hardly part with them at any price.

12. *Discovery of Viviparous Fish in Louisiana;* by B. Dowler, M.D., (from the N. O. Med. and Surg. Journal.)—In the month of October, 1854, through the politeness of J. C. B. Harvey, M.D., of Tchoupitoulas street, I received a small osseous fish, caught in the New Orleans Canal, which connects the city with Lake Pontchartrain. This fish had been placed in a basket containing crabs, one of which wounded it slightly in the abdomen near the cloaca, thereby exposing several fœtal fish enveloped in a delicate membrance. The parent fish, which had been rudely thrust into a narrow-mouthed phial of spirits, retains after immersion for two weeks, the original *rigor mortis*, and the same remark applies to the fœtuses, though they have been soaked in water: some of them have been forcibly straightened. On the 17th of October, in the presence of, and assisted by Dr.'s J. Hale and M. M. Dowler, I enlarged the wound and proceeded to dissect a somewhat globular mass of fœtuses bounded by the intestines before, and separated from

* The specimen was found by a brother of Capt. Ord, U. S. A., from whom I procured the specimen for description.

them by an indescribably thin, diaphanous membrane; this mass was further bounded above by the spine and ribs, below and behind by the posterior inferior abdominal walls, bulging backward of the anal orifice and fin. The exterior envelop of this oblong globe consisted of a very thin, pelucid, extremely delicate and apparently laminated and flocculent membrane, like the amnion of the human embryo in the early state; it did not form a simple sack, but consisted of many duplications like the arachnoidal reflections among the sinuosities and convolutions of the human brain, sending its prolongations as the hyaloid membrane does, through the vitreous mass of the eye.

This uterine membrane (ovisac it may not be termed) contained twenty-two fishes. It is probable that the inner surface of the uterine membrane sent forth a still more delicate membrane which enveloped each fish after the manner that the peritoneum envelops the abdominal viscera; but the parent fish, and still more its inclosed organs, were too minute to admit of full demonstration during a necessarily hurried examination; moreover the wish not to mutilate the parent fish very much prevented a fuller dissection of the fœtal mass *in situ*.

Each fœtal fish was doubled laterally, sometimes to the right, sometimes to the left into the globular form, the caudal fin which is inclined to the lancet shape, though blunter, overlapped one eye and one side of the mouth; each fish *in situ*, and even after forcible extraction from its bed was infolded in a sack; some were drawn out united by pedicles to a common stem, somewhat like an umbilical cord.

These fœtal fishes presented a perfect example of close packing. A perceptible force was required to dislodge them from their beds. The concavity left by their extraction appeared to be lined with a smooth, black, peritoneal membrane.

The intestines which were very minute were crowded forward by the rounded mass of fœtuses which occupied the greater portion of the abdominal cavity. No ova were discovered.

The maternal fish not being much mutilated, is reserved for a more detailed technical description, which my leisure and the limits of this Journal will not admit of at present.

Without attempting fully to describe even the dermal skeleton, I may observe that this tiny fish is a most symmetrical one. Its minuteness may be imagined when I state that after the removal of the inclosed fœtuses it weighed only seven grains, though not disembowelled. Thorough desiccation would probably reduce its weight one half or more. The fish exposed for two hours in the shade on a damp day, was but slightly desiccated. It was weighed by Mr. Macpherson, apothecary, in my presence; but fearing a mistake I had it weighed the second time, with the same result. If each fœtus should weigh but one grain, the aggregate would be more than three times greater than that of the mother.

Measurements in inches: Length including the caudal fin 2 inches; greatest circumference $1\frac{3}{4}$; width vertically $\frac{1}{2}$; length of thoracic fin $\frac{1}{4}$; the caudal fin does not expand from its base or proximal end, but terminates ovally, its length $\frac{1}{2}$; the anal but little expanded $\frac{1}{4}$; the ventral is too minute for convenient measurement, being almost invisible without a lens; the dorsal which is single, has but a slight vertical width,

arising from a base ¼ of an inch, nearly opposite, though a little forward of the anal.

The teeth are advanced, nearly ranging with the lips, being very numerous, close and small, though scarcely discernible without a magnifying glass. Lips thin, the under one slightly projecting; angles of the mouth not depressed; eyes medium size; head flattened at the frontal bone; operculum much expanded. The branchiæ largely developed in three great arches, densely fringed with thick tufts, the outer and inner rows inclining to the central, having also, one, perhaps more rows behind, which are shorter.

The predominant hue of this fish is a tawny or fawn color; the opercula silvery; head metallic gray; muzzle blackish, slightly projecting.

There are six rows of rather quadrangular black spots, more particularly marked in the posterior half of the body, averaging twenty-five spots for each row. These black spots, resting on a tawny ground, leaving intervals something larger than themselves, give a picturesque appearance, forming stripes of alternating hues, the three upper of which slightly curve corresponding to the arching back; but each becomes straighter, the fourth and fifth being nearly straight; the sixth or lower row follows the abdominal curve, and disappears at the anal fin; the other five rows gradually converge without coalescing at the origin of the caudal fin. At the origin of this fin the spots are displaced out of a line. By this arrangement the six rows of alternating black and tawny leave in the longitudinal direction six other continuous tawny stripes, all of which except the two interrupted ones, lost at the anal fin, converge without mingling in the tail, all being about equal in length. The colors fade somewhat into a greyish yellow around the thoracic fins, which are nearly central between the dorsum and abdomen, being on a level with the eyes, and about one line from the opercula.

There are six or seven rows of scales. The spinous rays of the fins are about twenty-five caudal, twelve anal, fifteen dorsal, ten thoracic.

The fœtuses are half an inch long, all alike, exactly resembling the maternal form and proportion, with the following slight exceptions, namely: their bodies are more slender and compressed laterally; their heads are comparatively larger, and their eyes more prominent; their colors are less variegated, and paler; a still greater difference appears about the middle of the abdomen, where there is attached to each fœtus a whitish, faintly yellowish, placental-like irregularly formed mass of considerable size, having a broad base, being apparently implanted in or blended with the abdominal intergument, possessing considerable strength and constituting what may be termed the umbilical prominence; perhaps, it may turn out upon further examination that this mass may be not placental, but an adherent mesenteric mass of convoluted membrane.

These fœtal fishes were probably sufficiently developed at the time of the parent's death to live independent of the mother.

It appears from the Proceedings of the Academy of Natural Sciences of Philadelphia, for 1854, that Dr. Gibbons, of the Academy of Natural Sciences of San Francisco, "claims priority of description of viviparous fish," in behalf of the gold-shimmering waters of California, and

consequently, that State takes precedence over Louisiana. Agassiz, whose sounding (fishing) line has passed the living waters to the most ancient palæozoic rocks, says, in regard to the California viviparous fishes, that "a country which furnishes such novelties in our days, bids fair to enrich science with many other unexpected facts."

The remarks of Dr. Dowler upon a viviparous fish of Louisiana, contained in the above notice, add a few points to the unpublished facts connected with the history of that family. The fish itself is not new; it has already been described and figured in 1821 by Lesueur in the 2d volume of the Journal of the Academy of Natural Sciences in Philadelphia, under the name of Pœcilia multilineata. It belongs to my family of *Cyprinodonts*.* I have had ample opportunity of observing large numbers of this fish during my stay in the South in the spring of 1853, in Mobile and in New Orleans where it is found everywhere in the lagoons in the immediate vicinity of these two cities, and not only of ascertaining that they are viviparous as I have already mentioned in this Journal for July, 1853, (p. 135,) but also of tracing the whole development of the embryo from the first stages of the segmentation of the yolk to the hatching of the young, which were freed from the abdominal pouch of the mother in the month of April. The date of the observations of Dr. Dowler seem to show that they breed twice a year. I should have hastened to publish my investigations had not Duvernoy already published a very full account of the later period of the embryonic growth of another species of this genus, the Pœcilia surinamensis, *Val.*, in the Annales des Sciences Naturelles, 3d series, vol. i, p. 313, plate 17, to which my own observations, except with reference to the earlier changes of the embryo will add comparatively little, when published. That the fish observed by Dr. Dowler is the same as that I had an opportunity of investigating, his description shows very plainly. There is only one fact to which I would call again attention though I have already noticed it before, that the genus Mollienesia of Lesueur is founded upon the male of the same species he has described as Pœcilia multilineata. There can not be the slightest doubt about it, for I have repeatedly seen them copulate, and among a large number of specimens examined, all those that answer to the description of Mollienesia latipinna are males and all those corresponding to the description of Pœcilia multilineata are females. There are several species of this family much smaller than this Pœcilia multilineata. Indeed it contains the smallest representatives of the great type of Vertebrates. My Heterandria formosa, for instance, when full grown, is not quite an inch long and does not weigh more than five grains. An adult male weighed $33\frac{1}{2}$ milligrams.

Cambridge, Aug. 22, 1854. L. Agassiz.

13. *Perforating Animals.*—M. Valenciennes observes that there are several Echini that perforate rocks like the Lithodomi. He also states that he has endeavored to obtain evidence of the presence of acid for perforating in different perforating animals, but has never detected the slightest alteration of litmus paper while in contact with them; and he admits that the action is wholly mechanical, proceeding from the incessant friction of the fleshy foot or some other part of the animal.—*L'Institut, Oct.* 11, 1854.

* See Agassiz's Recherches sur les Poissons fossiles, vol. v, part 2d, p. 47.

14. *Mollusca of Irkutsk.*—M. Maack has recently sent to the Academy of St. Petersburg, 27 species of mollusca, both land and fresh-water species, and it is remarkable that all the species without exception, are those of Europe, and pertain even to the most common and most widely distributed species; only four of them had not previously been observed in Siberia.—*L'Institut, Oct.* 11, 1854.

IV. Astronomy.

1. *Elements of Urania* (30), (Compt. Rend. Acad. Sci., tome xxxix, p. 644.)—Mr. Oudemans has computed the following elements of this planet from the Regent's Park observations of July 22, and those of Leyden of August 12 and Sept. 5.

Epoch July 22·0 Greenwich M. T.

Mean anomaly,	298°	13′	17″ ·4	
Long. perihelion,	26	42	59 ·3	Mn. Eqnx.
" asc. node,	307	57	51 ·15	1854·0.
Inclination,	1	56	41 ·7	
Angle of excentricity,	8	54	39 ·2	
Mean daily motion,		979·715		
Semi axis major,		2·35833		

2. *Comet*, 1854, IV, (Astron. Journal, 77 and 78.)—Mr. Van Arsdale has been anticipated in the discovery of this comet by Mr. Klinkerfues, who saw it on the 11th of September. The following parabolic elements of its orbit are published by Dr. B. A. Gould, Jr.:

T. 1854, Oct. 27·35980 Greenwich M. T.

Perihelion passage,	94°	12′	49″·1	Mn. Eqnx.
Long. asc. node,	324	35	33 ·9	1854·0.
Inclination,	40	59	28 ·8	
Log. q.	9·903504.			

3. *New Planets.*—Two new asteroids have been discovered in Paris: one Oct. 27, by Mr. Goldschmidt, which has been named Pomona (32), and the other Oct. 29, by Mr. Chacornac, named Polymnia (33). Their positions at that time were:

(32) R. A. $2^h\ 24^m$ and Dec. $+14°\ 55'$
(33) " $2^h\ 34^m$ " " $+16°\ 58'$

V. Miscellaneous Intelligence.

1. *On the Means of Realizing the Advantages of the Air-Engine;* by William John Macquorn Rankine, Civil Engineer, F.R.S.S., Lond. and Edin., &c.—This paper consists of four sections. In the first are explained the two fundamental laws of the mechanical action of heat, and their application to determine the efficiency of theoretically perfect engines working between given limits of temperature; and it is shown that, as the efficiency increases with the distance between those limits, and as it is easy to employ air with safety at temperatures far exceeding that at which the pressure of steam would cease to be safe and manageable, the maximum theoretical efficiency of air-engines, consistent with safety, is much higher than that of steam-engines. For example, at the temperature of 650° Fahr., at which the air-engine has

been successfully worked, the pressure of steam is 2100 lbs. on the square inch, while that of the air is optional, being regulated by the density at which the air is employed.

In the second section, the various causes of waste of heat and power in steam-engines are classified, and the actual efficiency of steam-engines is compared with their maximum theoretical efficiency, and also with the maximum actual efficiency, which may reasonably be supposed to be attainable in the steam-engine, by means of any probable mechanical improvements.

The following are estimates of the consumption of bituminous coal of a specified quality, per horse-power per hour :—

1. For a theoretically perfect engine working between such limits of temperature as are usual in steam-engines,..... 1.86 lbs.
2. For a double acting steam-engine improved to the utmost probable extent,..... 2.50 "
3. For a well constructed and properly worked ordinary double acting engine, on an average,..... 4.00 "

In the third section, the causes of waste of heat and power in air-engines, are classified in a manner analogous to that applied to steam engines ; and the actual efficiencies of those previous air-engines, as to which satisfactory experimental data have been obtained, namely, Stirling's engine and Ericsson's engine of 1852, are compared with the efficiencies of theoretically perfect engines working between the same limits of temperature, the results being as follows, so far as they relate to the consumption of coal of the specified quality per horse-power per hour :—

	Actual Consumption.	Consumption of a Theoretically Perfect Engine.
Stirling's Engine,.....	2.20 lbs.	0.73 lbs.
Ericsson's Engine,.....	2.80 "	0.82 "

It is thus proved that an air-engine has actually been made to work successfully, and to realize an economy of fuel considerably superior to that of ordinary steam-engines, and, in fact, surpassing the utmost limit to which it is probable that the economy of double-acting steam-engines can ever be brought. Stirling's engine, as finally improved, was compact in its dimensions, easily worked, not liable to get out of order, and consumed less oil, and required fewer repairs than any steam-engine. Still the advantages shown by that engine over steam-engines were not so great as to induce practical men to overcome their natural repugnance to exchange a long tried method for a new one ; another circumstance caused Stirling's and Ericsson's engines to meet with neglect from scientific men, namely, that both were by some persons represented as instances of *power created out of nothing*—the popular delusion commonly called "*perpetual motion*." It is shown that Stirling's air-engine, as compared with a theoretically perfect air-engine, wasted two-thirds of its fuel, and Ericsson's somewhat more.

Two obvious and powerful causes of that waste of fuel are traced—1. Deficiency in extent of heating surface. 2. The communication of heat from the furnace to the working air at those periods of the stroke when it is not performing work.

The necessary conclusion is, that the more completely we remove those two causes of waste of fuel, the more nearly shall we approximate to the theoretical extent of the economy of the air-engine—an ex-

tent far exceeding that to which the economy of the steam-engine is restricted; and the more fully, in short, shall we accomplish that which has hitherto been very imperfectly done—to REALIZE THE ADVANTAGES OF THE AIR-ENGINE.

The fourth section describes the improved air-engine of Messrs. James Robert Napier and W. J. Macquorn Rankine. In this engine the heating surface is increased to any required extent, by means of tubes employed in a peculiar manner. The waste of heat by its communication to the air, at improper periods of the stroke, is prevented by a sort of plunger, called the heat-screen, which prevents any access of the air to the heating surface, except when it is in the act of expanding, and so performing work. The engine may be made of the same size with a steam-engine of the same power, or smaller, according to the degree of condensation at which the air is employed. The air receivers of an experimental engine were completed some time since, without practical difficulty, notwithstanding the novelty of their construction; but the erection of the engine has been retarded by delay in the execution of the cylinder, fly-wheel, shaft, and other parts, which are similar to those of a steam-engine.

Independently of the amount and value of the saving of fuel, which will result from the introduction of the air-engine, it possesses the important and incontestable advantage, that even should an air receiver burst (which is very unlikely), the explosion would be harmless, for its force would not be felt beyond the limits of the engine itself. Red-hot air does not scald.—*Proc. Brit. Assoc., Sept.*, 1854.

2. *On Lightning Conductors*, (Proc. Brit. Assoc., Athen., No. 1405.)—Mr. NASMYTH described a Lightning Conductor for Chimneys, which he conceived affords more perfect insulation, and is therefore safer than those in common use. The present practice is to fix the conductor outside the chimney by metal holdfasts, by which means during severe thunder-storms chimneys are often damaged by the lightning entering at the points of attachment and displacing the bricks. In the method of fixing the conductor recommended by Mr. Nasmyth, the metal rod is suspended in the middle of the chimney by branching supports fixed on the top. A conductor of this kind had proved efficient in storms which had severely injured other chimneys in the neighborhood that were protected in the usual manner. An experience of eighteen years had tested the superiority of the plan.

Prof. FARADAY, on being called on for his opinion, said that he recommended that *lightning conductors should be placed inside instead of outside of all buildings.* He had been consulted on that point when the lightning conductor was fixed to the Duke of York's Pillar, and he advised the placing it inside, but his advice was not taken, and the rod was fixed outside, to the great disfigurement of the column. All attachments of metal to or near the conductor are bad, unless there be a continuous line of conduction to the ground. He mentioned the instance of damage done to a lighthouse in consequence of part of the discharge of lightning having passed from the conductor to the lead fastenings of the stones. The practical question for consideration by the Mechanical Section was, how far they could safely run lead between the stones of such a structure, for if it were done partially, leaving a

discontinuous series of such metallic fastenings, there would be great danger of the stones being displaced by the electric discharge. When such fastenings are used, care should be taken that they are connected together and with the earth by a continuous metallic conductor. Some persons conceived that it is desirable to insulate the conductor from the wall of a building by glass, but all such contrivances are absurd, since the distance to which the metal could be removed from the wall by the interposed insulator was altogether insignificant compared with the distance through which the lightning must pass in a discharge from the clouds to the earth. On being asked whether a flat strip of copper was not better than a copper rod, Prof. Faraday said the shape of the conductor is immaterial, provided the substance and quality of the metal are the same.

3. *On the Effect of Pressure on the Temperature of Fusion of different Substances;* by Mr. Hopkins, (Proc. Brit. Assoc., Athen., No. 1406. —The author began by stating that it was most fortunate for the success of his researches that, in the very commencement of them he had applied to Mr. W. Fairbairn, who had with the utmost enthusiasm, entered into his views, and aided him to the utmost extent of the incomparable facilities afforded by his celebrated establishment. Mr. Hopkins then gave a short description of the apparatus which he had used, and the successive steps by which failures in some contrivances had led him to that which was ultimately found to answer. In particular, how, from the enormous pressures to which the substances were subjected, they found it impossible to use glass to see what was going on within the cylinders in which the substance to be experimented upon was inclosed; which difficulty had been got over by causing an iron ball to rest on the top of the substance within the cylinder, while its presence deflected a small magnetic needle outside, but the instant the melting of the substance inside permits the ball to fall, the magnetic needle returning to its position of rest indicated the fact. The use of this needle made it necessary to make the cylinder of brass; and Mr. Hopkins stated that with the first cylinder they used, they were surprised to find when enormous pressures were laid on, that the liquid within wasted; the cause of this they long sought to discover in vain, until at length they found that it was escaping through the very pores of the metal in thousands upon thousands of jets so minute as to be almost imperceptible. This they remedied by greater care in the casting of the cylinder, and hammering it well on the outside. The method of laying on the pressure was by a piston well packed and forced down by a lever. This they adopted as the simplest means of getting a numerical estimate of the actual compressing force. Mr. Hopkins then described the method by which the friction had been determined which opposed the motion of the piston, and so diminished the pressure by so much. This was done by noting the weight required to drive the piston in a certain small distance: this, less by the friction, was equal to the compressing force; then noting the weight which allowed the piston to return exactly to its first position: this, together with the friction is equal to the compressing force; but as these two compressing forces are equal, the friction is equal to half the difference of the two weights used, and is then a matter of very simple calculation. Mr. Hopkins then gave the results of the experiments, of which the following are the most important:—

Substances experimented upon.	Pressure in lbs. to the square inch.			Temperature, Fahr., at which it liquefied.		
Spermaceti, -	0	7,790	11 880	124°	140°	176 5°
Wax, - - -	0	7,790	11,880	148·5	166·5	176 5
Sulphur, - -	0	7,790	11,880	225	275·5	285
Stearine, - -	0	7,790	11,880	158	155	165

Of course when the weight 0 was on the piston, the substance was under atmospheric pressure, or about 15 lbs. to the square inch; and the pressure of 7,790 to the square inch was just that at which the Britannia Bridge had been raised. Mr. Hopkins had also tried the metallic alloys which fuse at low temperatures, but had not detected any elevation of fusing temperature required by increasing the pressure; but these experiments required to be repeated and confirmed before they could be relied upon.

4. *M. Foucault's Nouvelles Expériences sur le mouvement de la terre au moyen du Gyroscope*,* (Proc. Brit. Assoc., Athen., No. 1406.)—The author spoke in French, but very distinctly, and the apparatus was so simple, beautiful, and exquisitely constructed, that the experiments all succeeded to a miracle, and fully interpreted the author's meaning as he proceeded. The gyroscope is a massive ring of brass connected with a steel axis by a thinner plate of the same metal, all turned beautifully smooth, and most accurately centred and balanced; in other words, the axis caused to pass accurately through the centre of gravity, and to stand truly perpendicular to the plane of rotation of the entire mass. On this axis was a small but stout pinion, which served when the instrument was placed firmly on a small frame, containing a train of stout clock-work, turned by a handle like a jack, to give it an exceedingly rapid rotatory motion on its axis. But to this clock-work frame it could be attached, or detached from it, instantly. This revolving mass was only about three inches wide, and four of them were mounted in frames a little differently. The first was mounted in a ring, attached to a hollow sheath, which only permitted the axle and the pinion to appear on the outside, so that it could be laid hold of, or grasped firmly in the hand, if the pinion were not touched, while the mass inside was rapidly revolving without disturbing that motion. By this modification of the gyroscope, the author afforded to the audience a sensible proof of the determination with which a revolving mass endeavors to maintain its own axis of permanent stable rotation, for upon setting it into rapid rotatory motion, and handing it round the room, each person that held it found himself forcibly resisted in any attempt to turn it round either in his fingers, to the right hand or left, or up or down, or in his hands if he swung it round. So that the idea was irresistibly suggested to the mind, that there was something living within which had a will of its own, and which always opposed your will to change its position. The second modification presented the mass suspended in a stout ring, which was furnished with projecting axles, like the ring of the gimbal. These axles could be placed in a small frame of wood bushed with brass. This small frame, when placed on a piece of smooth board, could be turned freely round by turning the piece of board on which it rested as long as the gyroscope was not revolving, friction being sufficient to cause the one to turn with the other; but,

* See this Journal, xv, 263.

when the gyroscope was set rapidly revolving, in vain you attempted to turn the frame, by turning the board on which it rested, so determinately did it endeavor to maintain its own plane of rotation, as quite to overpower the friction. In the third modification of the gyroscope it was suspended in gimbals, so exquisitely constructed that both the gyroscope proper and the supporting gimbals were accurately balanced, so as to rest freely when placed in any position in relation to the earth. By this the author showed most strikingly the effect of any attempt to communicate revolving motion round any other axis to a mass already revolving, for, on placing the gimbals in a frame of wood while the gyroscope was not revolving, it remained quite steady; but, when thrown into rapid revolving motion, the slightest attempt to turn the frame round to the right or to the left was instantly followed by the entire gyroscope turning round in the gimbals, so as to bring its axis to coincide with the new axis you endeavored to give it, with a life-like precision, and always so as to make its own direction of revolution be the same as that of the slightest turn you impart to it. Having thus demonstrated the necessary effect of combining one rotatory motion with another, he then proceeded to demonstrate palpably that the earth's revolving motion affected the gyroscope in precisely a similar way. Having, by the screw adjustments, brought the gyroscope, in gimbals, to a very exact balance, it remained fixed in any position when not revolving. But, rapid rotatory motion having been communicated to the gyroscope mass as soon as the gimbal supports are placed on the stand, you see the entire apparatus, slowly at first, but at length more rapidly, turn itself round, nor ever settle until the axis, on which the gyroscope is revolving, arranges itself parallel to the terrestrial axis, in such a sense as to make the direction of the revolving gyroscope to be the same as that of the whole earth. He next showed that the determination with which it did this was sufficient to control the entire weight of the instrument, though that amounted to several pounds, for, taking the ring gyroscope from the side of the ring of which a small steel wire projected, ending in a hook, the wire coincided with the prolongation of the axis of the gyroscope: of course, when not made to revolve, the hook, if placed in a little agate cup at the top of a stand, would permit the instrument, by its weight, to fall instantly, as soon as the support of the hand was taken from it. But, upon imparting to it rapid rotatory motion, it stood up even beyond the horizontal position, so as to bring its axis of rotation nearly to the same inclination to the horizon as the axis of the earth, while the whole acquired a slow rotatory motion round the point of the hook; and so steady was its equilibrium while moving thus, that a string being passed under the hook and both ends brought together in the hand, the whole may be lifted by the cord off the stand and carried revolving steadily about the room. Next, to show the motion of the earth sensibly, he placed the gimbal gyroscope suspended freely by a fine silk fibre in a stand with the lower steel point of its support resting in an agate cup; a long light pointer projecting from the ring carried a pointed card which passed over a graduated card arch of a circle placed concentrically with the gyroscope; upon imparting rapid rotatory motion to the gyroscope, the index was seen as the earth moved to point out the relative motion of the

plane of rotation exactly in the same way ; the law of the motion being also the same as that of the well-known pendulum experiment. Lastly, he set the ring gyroscope in motion, and by placing a small pointed piece of brass at the end of the axle on the ring, the instrument went immediately through all the evolutions of a boy's top on the floor, humming meanwhile loudly also.

5. *On Meteorolites and Asteroids;* by R. P. Greg, Jr., (Proc. Brit. Assoc., 1854, Athen., No. 1405.)—Mr. Greg brought forward some facts respecting meteorites and asteroids, not hitherto noticed, in favor of the theory that they are identical in nature and origin. After stating some arguments against the theory of the atmospheric origin of aerolites, Mr. Greg proceeded to give an abstract of some results he had lately obtained in analyzing a very complete catalogue of aerolite falls. It would appear that since the year 1500 A.D., there are 175 authenticated instances of falls of aerolites, the month of whose fall is known. The number for each month being as follows :—For January 9, February 15, March 17, April 14, May 15, June 17 falls,—first half of the year, 87 falls; July 18, August 15, September 17, October 14, November 16, December 8 falls,—second half, 88 falls. Giving an average of 14·6 for each month. The most important thing to notice is the small number of aerolites registered for the months of December and January, and the comparatively large number for June and July. The former two showing but 16 instances of falls, the latter two 35, or more than double. Now, granting that these aerolites, or meteorolites, belong to the system of the asteroids, having orbits therefore whose mean distance is superior to the earth's orbit, it is certainly reasonable to conclude that it is when the earth is farthest from the sun, *i. e.* at her aphelion, that the meeting with aerolites is rendered most probable. This is what would appear really to be the case, for the earth is at her greatest distance from that luminary on the side of the summer solstice, *i. e.* in June and July, precisely the months shown to be most abundant in aerolites.

Mr. Greg then referred to a recent number of the *Comptes Rendus*, in which there is a paper by Le Verrier on the asteroids. M. Le Verrier shows by calculation that the sum of the mass of the fragmentary planets called asteroids cannot exceed one-fourth of the earth's mass : and also shows it probable that their mean mass or system is at its perihelion, and consequently nearest the earth, at the time when the earth herself is on the side of the summer solstice. This would appear again confirmatory of the theory that aerolites are the minute outriders of the asteroids. There would appear to be also further evidence, though of another kind. It has been supposed that some of the larger asteroids have irregular and angular surfaces, which is precisely the case with the majority of the meteoric stones which fall to the earth. Again, taking the average specific gravity of aerolites at 3·0 (they vary from 1·7 to 3·9), further indirect evidence is afforded as to their position with regard to distance from the sun, and, taking water as 1·0, the following table shows the relative densities of several of the planetary bodies, following the order of their distances from the sun :—Mercury, 15·7 ; Venus, 5·9 ; Earth, 5·9 ; Mars, 5·2 ; Aerolites, 3·0 ; Asteroids, (?), Jupiter, 1·4. Another circumstance relating to aerolites which was

alluded to by Mr. Greg was the periodicity of those bodies, and he mentioned more particularly the 19th of May, 29th of November, 13th of December, 15th to 19th of February, and 26th of July, as being aerolitic epochs, aerolite falls having been recorded on the following days:—February 10, 10, 13, 15, 15, 15, 18, 18, 18, 19, 19, 25, 27, 27; May 9, 10, 17, 17, 17, 18, 19, 19, 20, 22, 26, 26, 27, 28; July 3, 3, 4, 7, 8, 12, 14, 17, 18, 22, 24, 24, 26, 26, 26, 30; November 5, 7, 11, 13, 17, 20, 23, 25, 27, 29, 29, 29, 29, 30, 30; December 11, 13, 13, 13, 13, 13, 14, 28. In referring, however, to the epochs most remarkable for the periodical displays of luminous meteors, as November and August 9th to 14th days, Mr. Greg observed that the number of aerolites recorded as falling on those days is remarkably small, indeed under the average of the year, for out of 155 falls (the day as well as month of fall being known), but four have fallen between the 9th and 14th days of August and November. The aerolitic and (luminous) meteoric epochs also would appear to differ, with the exception of the 29th of November.

From this circumstance it seems probable that aerolites, and the majority of luminous meteors (especially periodic and conformable ones), are resolvable into separate classes; and in corroboration of this it may be mentioned, that, while the number of aerolites whose falls have been recorded are about equally divided for the first as for the second half of the year, this is very far from being the case with luminous meteors, by far the larger numbers of which are observed during the second half of the year, viz, from July to December. While, then, we conconsider aerolites as belonging to asteroids, with orbits superior to the Earth's, and partakng of the nature of true though minute planets, the majority of luminous meteors may be considered as having characters more in common with comets. It has been shown by several astronomers, as Olmsted, Peirce, Erman, and others, that the majority of periodic meteors have orbits inferior to the Earth's, and their perihelia near the planet Mercury. Mr. Greg concluded, after making some observations in favor of the self-luminosity of meteors, by suggesting the probability of their having a nature less dense than that of aerolites, but denser than that of comets, and that it is not improbable they have a fluid or viscid nature.

6. *Summary of the Weather for June, at San Francisco, California;* by H. Gibbons, M.D. (From the California Christian Advocate.)

	Mean temp. Sunrise.	Mean temp. Noon.	Mean temp. 10 P.M.	Monthly mean.	Warmest.	Coldest.	Range.	Warmest morning.	Coldest noon.	Proportion clear sky.	Proportion cloudy sky.	Whole days clear.	Whole days cloudy.	Mist.	Winds. NW & N	Winds. NE & E	Winds. SE & S	Winds. SW & W	Windy afternoon.	High winds	Rain.
										days	days	days	days	d's	ds	ds	ds	d's	d'ys	d's	ds
1851	50·90	66·73	51·80	58·81	78	49	29	56	60	20	10	10	0	5	2	1	2	25	24	10	0
1852	51·93	68·87	53·43	60·40	80	49	31	55	64	19	11	9	0	10	1	0	2	27	27	9	1
1853	52·67	71·07	55·57	61·87	87	50	37	60	60	25	5	18	0	7	2	0	2	26	25	8	0
1854	50·10	66·80	51·50	58·45	74	47	27	56	59	24	6	15	0	3	4	0	1	25	25	8	1

In 1851 and 1853 there was no rain, a trace in 1852, and 4 hundredths of an inch in 1854.

From the foregoing table it appears that the last June was the coldest of the series, both the means and extremes being lower than those of the same month in either of the preceding years. In June '51, the

mercury was below 50 on four mornings; in '52 on three mornings; in '53 on one morning only; and in '54 on eleven mornings. An unusual tendency to rain existed throughout the month—not the misting or drizzling rain common in the summer; but rain in big drops from the clouds in the higher regions of atmosphere. Light showers fell on the 1st, and on the night of the 11th; and rain fell moderately for several hours on the 17th, $\frac{4}{100}$ths of an inch collecting in the guage. Besides there were threatenings of rain on the 7th and 21st. Though the sea winds were constant and often high, they brought but little mist. The weather of the month was pronounced by general consent to be colder and more unpleasant than is warranted by the common reputation of the summer in this place.

It will be observed that in the four years not a single day occurred in June when the sky was cloudy from sunrise to sunset. This is in character with our summer weather. The mornings are frequently cloudy, without interruption, for one or two weeks, occasionally even for a longer period; but the clouds almost invariably disappear between 8 and 10 o'clock, often returning towards sunset or afterwards, in the form of driving mist. The tendency to cloud at night and in the morning generally increases as the summer advances, so that the number of cloudy mornings is greater in August and September, when the sea breezes have abated in force though not in constancy.

7. *Observations on Atmospheric pressure; from A. and H. Schlagintweit's "Untersuchungen über die physicalische Geographie und die Geologie der Alpen."*—(1.) A diminution of atmospheric pressure causes a small expansion of the thermometer-bulb, and a consequent depression of the zero-point. With delicate thermometers, made with large bulbs and especially with those used for thermo-barometric measures of altitude, the difference can amount, on high summits to 17 or 20 hundredths, (which would correspond to an error of 3 or 4mm. if in computing the atmospheric pressure the change of the zero-point were disregarded.)

(2.) In very great altitudes also, the local forms of the surface are not seldom without influence sufficient to change somewhat the daily range of temperature. Bare walls exposed to the sun act by absorption and subsequent radiation: favorably located snow surfaces can act by reflection so as to increase the maximum. The minimum also can, even in greater heights, be depressed sensibly, if the forms of the peaks favor descending cold currents of air. The increase of temperature which may result even before the appearence of the sun, and after the effect of the descending current has diminished is dependent upon the lateral influx of the free, less cooled masses of air.

(3.) The time of the maximum at high places, nearly agreeing with the culminations of the sun, appears to be somewhat independent of the maximum in the lower parts of the mountains and in the plains. The velocity of the ascending current, not very important on the average, causes that the heat produced in the plains does not ascend to altitudes of 9000 or 10000 feet before the later hours of afternoon.

(4.) On isolated fair days with strong sunshine, the temperature of the air near the ground, even at the height of the snow-region may deviate very sensibly from that of the free columns of air removed from all

effect of the heated ground. This heating can sometimes over tolerably extended spaces, amount to a difference of 8 or 10 degrees. This often shows, in the same manner as the corresponding local cooling by descending glacier-winds, an important difficulty in barometric measurement of heights.

(5.) The most important disturbances of the regular diminution of temperature in great surfaces may be produced by the influx of warm winds, which spread themselves generally from the upper regions downward. Sometimes it happens then, that in an air-column of more than 2000′ height the temperature shows no sensible diminution.

8. *On the Artificial preparation of Sea Water for Marine Vivaria;* by Dr. G. Wilson, (Proc. Brit. Assoc., 1854, Athen., No. 1405.) —The paper was a criticism on a communication made by Mr. Gosse, and contained in "The Annals of Natural History." Guiding himself by Schweitzer's analysis, Gosse employed chlorid of sodium, sulphate of magnesia, chlorid of magnesium and chlorid of potassium. Into a mixed aqueous solution of these salts, Gosse introduced various species of marine plants and animals; and for six weeks they throve and flourished. Dr. Wilson considers, however, that the less abundant, but still essential, constituents of sea-water—such as carbonate of lime, sulphate of lime, phosphate of lime, fluorid of calcium, silica, iodine and bromine—should not be absent, as these latter substances are found in marine plants and animals; and it is therefore plainly evident that the medium in which they live ought to contain the same substances. It is, of course, quite possible that in a single aquarium the death of a certain portion of the animals might furnish calcareous salts, &c., for the growth and preservation of their survivors; and in like manner the death of a given number of plants might liberate iodids, bromids, &c., for the remainder. But this destruction of part of the occupants of the aquarium for the preservation of the other part might be easily avoided, as calcareous phosphates, carbonates and fluorids occur together in shells, corals, and many limestones. The arrangement of fragments of such calcareous bodies at the bottom of the aquarium would supply some of the missing ingredients; whilst pieces of trap rock and a few grains of an iodid and bromid would afford the remainder.

9. *On the Results of Experiments on the Preservation of Fresh Meat;* by Mr. G. Hamilton, (Ibid.)—This inquiry was undertaken with a view of discovering a method by which beef could be brought in a fresh state from South America. The experiments were made by inclosing pieces of beef in bottles containing one, or a mixture of two or more of the following gases:—chlorine, hydrogen, nitrogen, ammonia, carbonic acid, carbonic oxyd, and binoxyd of nitrogen. Of these, the last two only possessed the power of retarding putrefaction. Beef that had been in contact with carbonic oxyd for the space of three weeks was found to be perfectly fresh, and of a fine red color. Binoxyd of nitrogen is capable of preserving beef from putrefaction for at least five months, during which time the beef retains its natural color and consistence. When meat that had been preserved by the last process was cooked by roasting, it was found to possess a disagreeable flavor. If cooked by boiling, the ebullition must be continued for a much greater length of time than is necessary for fresh meat.

Dr. CALVERT remarked, that he had opportunities of observing the well-known valuable anti-putrid properties of carbolic acid,—and instanced the case of the carcass of a horse that was at present in a fresh state, although four years had elapsed since it had been soaked in liquor containing the acid. He recommended the use of this acid for preserving bodies intended for dissection, as it neither affects the tissues nor discolors the organs.

10. *Magnetic Needle.*—M. Hansteen of Christiana, has made many new observations on the changes which the magnetic needle is undergoing in Europe and Asia. He observes among his results, that the inclination which is diminishing to the west of the line of no declination, is increasing on the contrary, to the east of this line. This law has just been confirmed by M. Simonov, by observations made at Kazan.

11. *Official Report of the United States Expedition to explore the Dead Sea and the River Jordan;* by Lieut. W. F. LYNCH, U. S. N.—Published at the National Observatory, Lieut. M. F. MAURY, U. S. N., Superintendent.—This official Report on the Dead Sea Expedition contains a valuable Report of 150 pages, presenting a "Geological Reconnaisance of part of the Holy Land," by Dr. HENRY JAMES ANDERSON. The general geographical features of the country are described, the characters of the rocks, their composition and fossils, the features of the Dead Sea Valley, the waters and sediment of the Sea, and other particulars of interest. The Fossils, of which there are numerous lithographic plates, are described by Mr. T. A. CONRAD, of Philadelphia. From the various facts this work affords, we cite the following analyses of the sediment and waters of the Dead Sea:—

The sediments were obtained at various depths and distances from the shore. The specimen selected for analysis was procured from a spot where the water had a depth of 116 fathoms, and was not far from the centre of the Sea. For greater precaution against any adventitious matter derived from the vessel in which it had been brought home, (a small well-tinned and closed box,) the portion submitted to analysis was carefully cut out of the interior of the mass which, in the course of the time elapsed (a twelve month) had contracted some degree of hardness. But if there be reason for supposing that the slight metallic addition due to the oxydation of the vessel had already diffused itself through the mud, there could not have been over one per cent. of iron ascribable to this source.

A preliminary experiment showed the following results, due to the moisture yet adherent:

Of 86·2 gr. submitted to a sand-bath heat of 200, after two hours there remained - - - - -	76·0
After five " " " - - - - -	69·5
The next day, after free exposure in the laboratory, -	68·9
After four hours more of sand-bath, - - -	68·7

It then ceased to lose weight.

Of what remained after expelling the retained humidity of this mud, I found soluble in water 20·5 per cent. This was analysed qualitatively and consisted mainly of chlorid of sodium, with minute crystals of

which the sediment was plentifully studded. The other chlorids existed nearly as in the Dead Sea water, the chlorid of magnesium being largely in excess.

Of that portion which was not soluble in water there was 57·5 per cent. soluble in hydrochloric acid. An analysis of this gave

Carbonate of lime,	74·7 per cent.
Carbonate of magnesia,	·4
Peroxyd of iron,	12·6
Alumina,	12·1

The remaining portion (42·5 per cent. of that part which water did not dissolve) was not soluble in hydrochloric acid, and consisted of

Silica,	85·1 per cent.
Alumina,	4·9
Peroxyd of iron,	2·5
Magnesia,	3·9
Lime,	3·3
Alkalies, (traces)	

This portion, as already observed, consisted mainly of a very fine quartz sand with about one-fourth more of minutely triturated silicate powder, derived partly from the basalts of the Valley of the Jordan and partly from the flints of the chalk.

As this specimen was obtained from a part of the Lake not very distant from the focus of the detrital deposits, it may be regarded as exhibiting the maximum of the most transportable matter and the minimum of the least. Yet the carbonate of lime exceeds the silica only in the ratio of 7 to 6. As the ratio of the lime to the silex in the detritus as first detached must far exceed this, it would seem to follow that, notwithstanding the large quantity of carbonate of lime in the Dead Sea sediment (far exceeding that of any marine delta,) a great deal of it has nevertheless disappeared, and must have undergone decomposition before reaching the sea, and probably before arriving at the Jordan.

Another conclusion (and one eminently deserving attention) to which we are brought by this result, if confirmed by further analyses, is that the magnesia so largely incorporated with the lime in the sources of the descending debris, is nearly exhausted on reaching the final resting place of the transported material. Most of the limestones in the Jordan Valley contain at least 2·30 per cent. of magnesia, and the dolomites of the western shore show even 23 per cent. Whereas we find but one-half of one per cent. in the oxylytic portion of the sediment, the only portion probably which has been derived from the calcareo-magnesian rocks. It would seem then that the magnesia in the Dead Sea water is extracted from the rock-powder by some other process than vegetable reaction, though this undoubtedly contributes; but I confess myself at a loss to suggest a *rationale* which can satisfactorily explain the extent of this disappearance. If the sediment contained a larger proportion of magnesia there would be no difficulty in looking to the magnesian chlorids in the lavas as competent to the effect, allowing time to do its work; but the carbonates have also contributed their share, and the decomposing process is yet to be detected.

Analysis of the Dead Sea Water.—The quantity submitted to analysis was drawn up by Capt. Lynch himself from a depth of 185 fathoms. The determination of its constituents was very carefully made by Professor Booth, of Philadelphia, assisted by Mr. Alexander Muckle I subjoin the results as already given in Captain Lynch's Official Report, submitted February 3, 1849.

Specific gravity = 1·22742.

Chlorid of sodium,	78·554
Chlorid of potassium,	6·586
Chlorid of magnesium,	145·897
Chlorid of calcium,	31·075
Bromine salts,	1·374
Sulphate of lime,	·701
	264·186
Water,	735·813
	1000·000

It may be remarked that the great specific gravity of this water does not indicate full saturation with any of the chorids, for the water is still capable of holding much chlorid of sodium, and of course still more chlorid of magnesium in solution. Since, however, crystals of chlorid of sodium remain undissolved at the depth of 116 fathoms,* it follows that the water of the Dead Sea is very unequally charged with its constituents, and that no safe inference can be drawn from an analysis of the surface water, and still less of any specimen in which the depth is not given. I will also add, that in two analyses of Dead Sea water for chlorid of calcium alone, I have found more of this salt than in the analysis above given, in one instance 48 gr. 47 in 1000; but the water was in these cases taken from another part of the Sea.

The fossils described by Mr. Conrad were either Jurassic or Cretaceous, but mostly the former. Concerning the fossil Ostreidæ, he observes:

It is worthy of remark, that some species of this family and of *Pectenidæ* are widely distributed throughout the globe. Thus *Pecten quinquecostatus* and *Ostrea vesicularis* occur in Syria, Europe and America. *Ostrea falcata* and *Gryphæa vomer* of Morton, originally discovered in the Cretaceous beds of New Jersey, occur in Europe also, where they have since been described under other names, and I have elsewhere stated, that *Exogyra Boussingaultii* is found in Syria, Europe and America.

12. *Illustrations of the Birds of California, Texas, Oregon, British and Russian America;* by John Cassin. *Philadelphia*, Lippincott, Grambo & Co.—We perceive with great satisfaction that the ornithological illustrations of Mr. Cassin continue to appear as regularly as the pages and plates of such a work can fairly be expected to come forth from the press. We have already No. 7 before us. Like the former, it contains a part of the general synopsis of the birds of North America

* They were found at this depth a little above 'Ain-el-Feshkhah. It is very probable, however, that they may be met with much nearer the surface.

(this time the close of the family of the Owls) and the description of several new or thus far little known species, which are here for the first time handsomely figured. While this book may be particularly acceptable to the lovers of finely illustrated works, and appear as an ornament upon any centre table, it constitutes a highly valuable addition to our scientific literature. To the naturalist who would follow up the general features of the feathered tribes, especially with reference to their geographical distribution and not merely enjoy the diversity of their species, nothing can be more attractive than to behold these careful delineations of birds from the recently annexed parts of the country, which at first sight might appear as simple repetitions of our common species, but are in reality newly discovered representatives of our eastern types in the specific garb they present west and south. L. A.

13. *Orr's Circle of the Sciences—Crystallography and Mineralogy;* Parts I, II, III, by the Rev. WALTER MITCHELL, M.A., and Professor TENNANT. 12 mo, 32 pp. each number. *London.*—In these three numbers, the authors have given the first part of a Treatise on Crystallography. The subject is presented from a mathematical point of view, and with much detail. The system adopted is in its main features that of Prof. Miller; but the symbols of Naumann, and Brooke and Levy, are given, as well as those of this crystallographer. The work promises to be a valuable one to the student of the Science.

14. *Edinburgh New Philosophical Journal.*—A new series of this valuable Journal is announced to commence with the 1st of January, 1855, under the editorial direction of EDWARD FORBES, F.R.S., Regius Professor of Natural History in the University of Edinburgh, and THOMAS ANDERSON, M.D., F.R.S.E., &c., Regius Professor of Chemistry in the University of Glasgow. With men so eminent in science at the head of this Journal, it will assuredly prove second to none in Great Britain. It will be issued quarterly as before, and retain the general excellent features it presented under Professor Jameson. The editors also propose to give analytical Reviews of Scientific Publications, Reports of the Proceedings of learned Societies, and notices of the contents of foreign Journals. The price of the Journal is reduced to 24s. per year.

[Since the above paragraph was put in type, we have received the following announcement of the death of Professor Forbes.]

"Amongst the younger men of science few have made so brilliant a career, or given promise of so much in the future, as Edward Forbes. Just as his friends were rejoicing in his having attained one of the most distinguished positions his country has to offer for the cultivation of natural history and in the leisure he had won,—looked to as a means of developing the rich store-house of facts and thought he was known to have accumulated,—he has been snatched from us. Never strong, he sunk under a malady from which he had suffered for some years on Saturday last, the 18th of November, in the thirty-ninth year of his age."—*Athen., Nov.* 25, 1854.

15. *Memoria sobre las Antigüedades Neo-granadinas, por* EZEQUIEL URICOECHOEA, 76 pp. small 4to. *Berlin.* Libr. de F. Schneider & Co.—M. Uricoechoea in this work writes like a scholar about a region with which he is familiar, and gives information both ethnological and histor-

ical as well as archæological, respecting the people and country of New Granada. The memoir is illustrated by four lithographic plates, the first representing images in gold of New Granada; the second, Crania; the third and fourth images in stone, and pottery.

16. *Denkschriften der Kaiserlichen Akademie der Wissenschaften, zu Wien.* Vol. vii. of the Mathematico-Natural-History Class, with 56 plates.—This volume of memoirs of the Vienna Academy of Sciences is one among the many scientific publications issued annually at Vienna. Among the papers, there is an elaborate one of 156 pp. by Dr. A. E. Reuss, on the Cretaceous rocks of the eastern Alps, which is illustrated by 31 quarto plates; the larger part of the plates are of fossil corals, and are among the most beautiful as specimens of art and fidelity that we have seen. There is also a paper by E. Suess on the Brachiopods of the Kossener beds (lower liassic) in the Austrian Alps, with four plates; and another by Fr. Unger, on the Fossil Flora of Gleichenberg.

The Sitzungsberichte or Bulletin of this Academy, a large and elegant 8vo publication, contains in its number for June, 1854, a paper on the Neuration of leaves of the Papilionaceæ, illustrated by numerous (22) plates of leaves taken by the automatic method mentioned in our last number, the leaves themselves making the engraving. The figures stand out on the paper, like actual specimens, and have all the perfection of nature.

17. *Economie Rurale, considérée dans ses rapports avec la Chimie, la Physique et la Météorologie*, par J. B. Boussingault. 2nd edit. 2 vols. 8vo, of 800 to 900 pages. *Paris*, chez Béchat, jeune.—M. Boussingault stands preëminent among the scientific agriculturalists of Europe. To talent of observation, he unites a synthetic power which has conducted him to admirable results. He not only enters into details of Rural Economy as presented in his beautiful place at Bechelbronn (department of the Bas-Rhin); but having seen and travelled much, he finds in his memory, many valuable illustrations of his subject. M. Boussingault has explored the principal volcanoes of America, and has scaled the highest peaks of the Andes; he has ascended Chimborazo, and passed 10 years in Peru and Chili. He recalls much of his travels in his Rural Economy, while still keeping to his subject, thus giving his work a cosmopolitan character. J. Nicklès.

18. *Traité des Arts Ceramiques ou des Poteries considérées dans leur histoire leur pratique et leur theorie par* Alex. Brongniart. 2nd edit. revue et augmentée par M. A. Salvetat. 2 vols. in 8vo, with an Atlas. *Paris*, chez Béchat.—After the French Revolution, the illustrious geologist and mineralogist, Alex. Brongniart was appointed to superintend the reorganization of the Manufacture at Sèvres. He had the direction of this establishment for nearly half a century, and raised it to a degree of splendor which entitles it to the first rank among the manufactures of the world. We owe to the skillful attention of Brongniart, the chefs d'œuvre which call forth so general admiration. By a judicious selection of artists and workmen he brought together a large amount of talent, as was seen at the London Exhibition and will be further exhibited in the Crystal Palace of 1855 at Paris. His position and influence have enabled him to form a Ceramic Museum,

in which all the nations of the globe are represented. A chapter on the potteries of different countries forms an interesting part of his Treatise on the Ceramic Arts. With full liberality all the different processes employed at Sèvres are explained in the work, and M. Salvetat, the pupil of M. Brongniart, has added a history of the art since the death of M. Brongniart in 1847. J. N.

19. *Cours special sur l'Induction, le Diamagnétisme, le Magnétisme de Rotation et sur les relations entre la Force Magnétique et les Actions Moléculaires*, par M. MATTEUCCI. 1 vol. in 8vo, of 280 pages. Paris, Mallet-Bachelier.—This work gives a review of the principal facts in these different branches as brought out both by Matteucci himself and by Arago, Faraday, De la Rive, Becquerel, Ampère, de Haldat, Poggendorff, Weber, etc. J. N.

20. *Nouveau Système de Navigation fondé sur le principe de l'emergence des corps ronds roulant sur l'eau; Hydro-locomotives à grande vitesse portées sur des cylindres roulants; vol á la surface de l'eau*, par PLANAVERGNE. A brochure in 8vo. of 100 pages with plates. The work describes and illustrates a new mode of navigation by which the vessel moves over the water instead of in it. J. N.

TRANSACTIONS OF THE AMERICAN MEDICAL ASSOCIATION, vol. vii. 668 pp. 8vo.—This volume contains a paper by F. Peyre Porcher, M.D., of Charleston, S. C., on the Medicinal and Toxicological Properties of the Cryptogamic plants of the United States.

W. J. MACQUORN RANKINE: On the Geometrical Representation of the Expansive Action of Heat and the theory of Thermodynamic Engines; Trans. Roy. Soc. 1854. p. 115. 60 pp. 4to.

QUETELET: Observations des Phénomènes Périodiques—Mém. Acad. Roy. de Belgique, Tome xxviii. 104 pp. 4to.

J. C. HOUZEAU: Méthode pour détérminer simultanement la Latitude, la Longitude, l'Heure et l'Azimut, par des passages observés dans deux verticaux; 26 pp. 4to. Mem. Bruss. Acad. *Brussels*, 1853.

F. A. QUENSTEDT: Handbuch der Mineralogie. 1 Lief. 8vo, 384 pp. Tubingen.

SCHLAGINTWEIT: Neue Untersuchungen über die Physicalische Geographie und die Geologie der Alpen. 4to, 630 pp. with an Atlas of 22 plates and 8 tables in folio. *Leipzig.* $24.00.

HINRICHS: Das Leben in der Natur Bildungs- und Entwicklungsstufen desselben in Pflanze Thiere und Mensch. 8vo, 271 pp. *Halle.*

CASSADAY of Louisville, Ky.: DESCRIPTION OF NEW CRINOIDS. (In German, from the Zeitsch. d. deutschen geologischen Gesellschaft, Jahrg. 1854.) This memoir describes two new Crinoids from limestone at the foot of Spergen Hill, 25 miles from New Albany, Indiana. They are referred to the new genus Batocrinus, and named *B. icosadactylus* and *B. irregularis*. The head is elongated and the pieces rise into cones over the whole surface.

J. MÜLLER: Ueber den Bau der Echinodermen, 100 pp. 4to, with 9 copper plates of great beauty. *Berlin*, 1854.

C. VOGT: Lehrbuch der Geologie und Petrefactenkunde. 2nd edit. 2 vols, 8vo, 672 and 641 pp., with 16 copper plates and 1136 wood-cuts. *Braunschweig*, 1854.

PROCEEDINGS OF THE ACAD. NAT. SCI. OF PHILADELPHIA. Vol. vii, No. 5.—p. 167. Descriptions of some new Fossils from the Cretaceous Rocks of the Southern States; M. TUOMEY.—p. 172. Description of a fossil apparently indicating an extinct species of the Camel Tribe; J. LEIDY.—p. 175. Catalogue and descriptions of Crustacea collected in California by Dr. John L. LeConte; JAMES D. DANA (contains new genera of Isopoda, *Alloniscus* and *Ægacylla*).—p. 177. Additions to North American Ornithology; A. L. HEERMANN.—p. 180. Descriptions of four new species of Kinosternum; J. LECONTE.—p. 190. Observations on the Vespertilio leporinus of Linnæus; J. LECONTE.—p. 191. On Urnatella gracilis and a new species of Plumatella; J. LEIDY.—p. 193. Descriptions of new Reptiles from Guinea; E. HALLOWELL.